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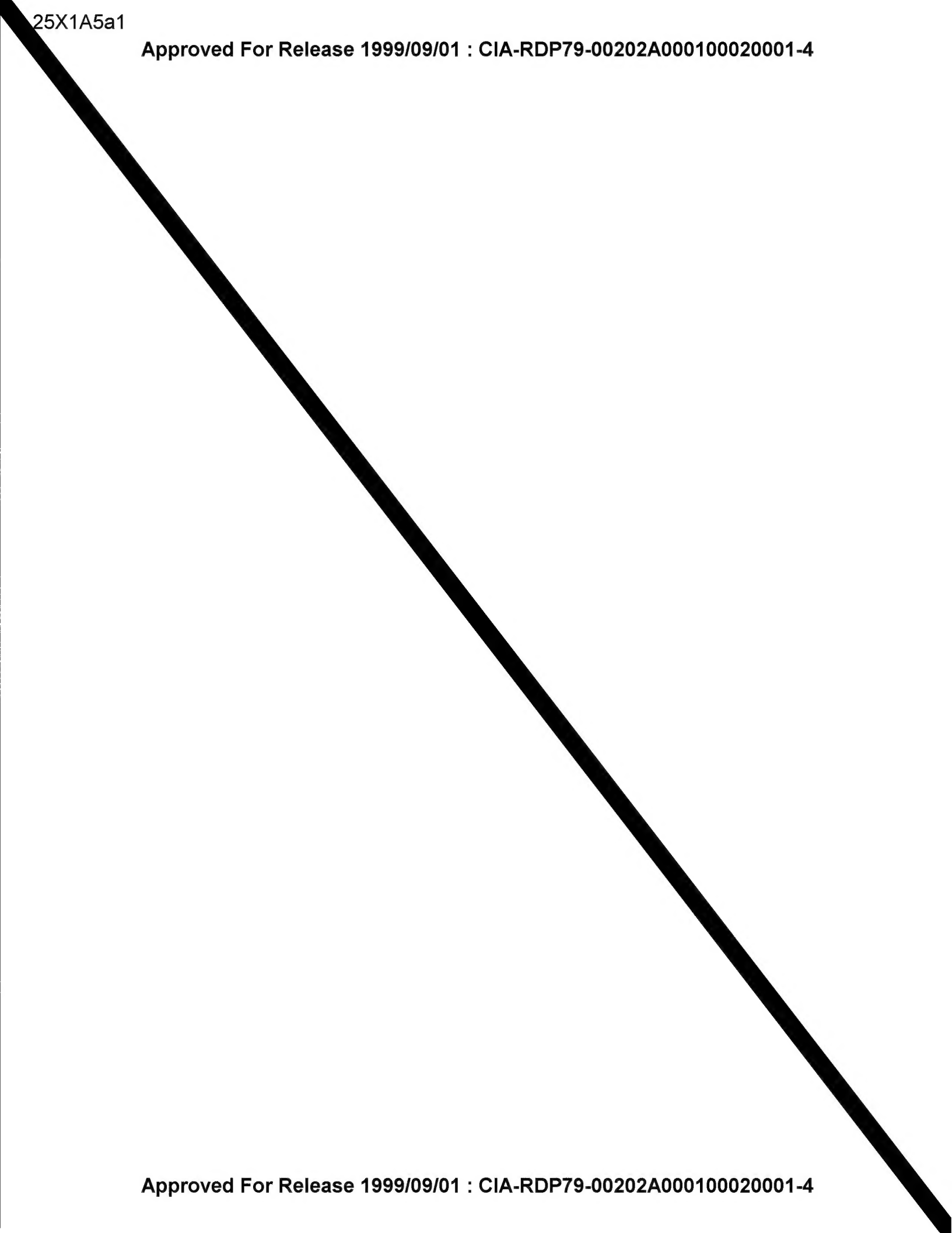

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SOVIET EDUCATION IN GEODESY AND CARTOGRAPHY

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ABSTRACT

This paper contains a discussion of Soviet research and training programs so far as it relates to the subject of geodesy and cartography. Part I describes the general organization plan for the school system, beginning with the elementary schools and ranging to those of institutions of higher learning. Part II deals in greater detail with training programs, educational and research institutes, publications, research and technological results in the fields of special interest, - geodesy and cartography. Some attention is paid to the history of the development of the Soviet educational system, especially as it affects the status of present scientists and their work. Part III contains a discussion of research carried out in the U.S.S.R. in the field of geodesy and cartography in the specialized institute as well as in other scientific organizations.

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CONCLUSIONS

1. The status of Soviet training and research in the fields of geodesy and cartography ought to be considered in a historical perspective. It is not the status of the Soviets in these fields in 1953 that is significant but the rate of progress from almost absolute zero in 1920 to a very large and elaborate structure in 1953 that surprises and impresses an unprejudiced investigator.

2. The outstanding feature of Soviet organization of research and training in our field of interest is the perpetual changes by no means restricted to the early period of Soviet reorganization of the country. It was found, for instance, that instruction in geography and cartography in universities underwent drastic changes in the period between 1950 and 1952. In view of lack of continuity of the record, and especially in view of paucity of information relating to the period after the war, most of our conclusions refer to the years 1945-46.

3. The Soviets evidently experienced lack of competent ordinary workers and some drastic moves were made to train such workers in the system FZO. Professional papers in geodesy and cartography are full of complaints on this score. Instructions for workers in field work and cartographic factories are extremely detailed and presuppose a very low technical level of workers. The Soviets are evidently aware of this situation and are trying their best to improve it.

4. In the intermediate training in geodesy and cartography, the Soviets by 1948 had nine topographic technicums and one school of aerial survey. The programs for these institutions have been found to be on a rather high level

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and in professional subjects these technicums should be considered as fully equivalent to the first two years of American universities. The enrollment in these schools in 1948 was about 2,000 students, and it is estimated that the Soviets by now should have at least 10,000 technicians available.

5. The highest level of training in geodesy and cartography is given in two specialized institutes, one in Moscow and the other in Novosibirsk. The program of instruction for the Moscow Institute of Engineers of Geodesy, Aerial Survey and Cartography was considered in detail and was found to be on the highest level. The existence of this institute alone with an annual enrollment of over 400 students would make the Soviets exceptionally strong in specialists in geodesy and cartography.

In addition to the Moscow institute and the smaller one in Novosibirsk the training of geodesists and cartographers is given in the Military Engineering Academy, in 27 universities (mostly geographers) as well as in a few other specialized schools. It is estimated that by 1953 the Soviets should have 10,000 highly trained specialists in geodesy, aerial survey and cartography, of which the Moscow institute alone accounts for 6,000.

The emphasis put by the Soviets on the continuation of training after graduation is also noteworthy. The engineers in production are not allowed to become committed to familiar methods and apparently are forced in some way to take refresher courses and become acquainted with new developments in their specialties. The large number of engineers taking these refresher courses (700 in 1938 in the Moscow institute alone) indicates either direct compulsion or some benefits in advancement in their service. At any rate it is clear that the Soviet government expects their engineers to be fully abreast of the newest developments in their profession.

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The conclusion seems inescapable that the Soviets have the best training system in geodesy and cartography in the World. As for the large number of highly trained specialists in these subjects there cannot be any doubt and it is possible that the Soviets produce more of them than the rest of the World put together. As for the quality of these experts, the conclusion is less certain. The instruction programs, published textbooks and the amount and character of research published by the Soviets along these lines definitely indicate a level of training fully comparable to that in Western schools.

6. Research in the U.S.S.R. in geodesy and cartography is carried on in all institutions already mentioned. In fact considerable emphasis is on the desirability and necessity of research by instructors whose primary duty is teaching. However, by way of research the Soviets have a large institution wholly devoted to this problem. This is the Central Research Institute of Geodesy, Aerial Survey and Cartography in Moscow (TsNIIGAiK). As early as 1935 there were 172 persons on the scientific staff of this institute. No later figure is available but one may expect a considerably larger staff at the present time.

Some research on specialized problems of geodesy and cartography is done in other research institutes, of which the Research Institute of Military Topographic Service should be especially mentioned.

The evaluation of Soviet research is done in other reports on specific problems of geodesy and cartography. A few general features of Soviet research may be mentioned here:

(a) A very large volume of research. It is evident that a comparatively small fraction of openly published Soviet research papers and books ever reaches this country. There must be also a considerable

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amount of classified research, of which we know almost nothing. There can be little doubt that in the bulk of research on the problems of geodesy and cartography, the U.S.S.R. exceeds any other country, and perhaps even all other countries combined.

(b) The quality of research is difficult to estimate, owing to conspicuous gaps in our information. One is impressed with the amount of attention paid by the Soviets to comparatively trivial subjects. However, there is much excellent work being done in the U.S.S.R., of which the determination of the reference ellipsoid, (Krasovskiy and Izotov), and application of gravimetry to geodetic problems, (Molodenskiy, Zhongologich and Zagrebin), should be mentioned. Such work requires participation of many persons. Since it is by its nature very expensive, this indicates the realization of its importance by the Soviet government.

(c) The Soviet writers invariably display a very thorough and up-to-date acquaintance with results obtained in their field of effort in the West. Many articles and whole books have been published in the U.S.S.R. on the state of geodesy and cartography in foreign countries, including the U.S.A.

(d) There seems to be very little political interference in research so far as geodesy and cartography is concerned.

7. The conclusion is that the Soviets have a very much better organization of training and research in geodesy and cartography than any other nation in the World. They are now nearly, if not quite, the leaders in the World in such branches of geodesy and cartography as gravimetric geodesy and

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and mathematical cartography. The situation is less clear in photogrammetry and especially radiolocation, but it has been established that the Soviets pay great attention to these subjects.

In other words, the Soviets have the capability to forge ahead of the rest of the World in the general subjects of geodesy and cartography. Whether this will actually happen will depend on two factors which could not be considered in the present report:

(a) Whether the Soviets will succeed in raising the cultural, scientific and technical level of the whole population to keep up with the striking development of training on the higher level end of research.

(b) Whether research and training will be spared serious political interference.

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GENERAL INTRODUCTION

Adequate analysis and evaluation of any aspect of both the Soviet scientific actuality and potential must be prefaced by as complete a comprehension of the basic fundamentals of Soviet life, philosophy, mores, and history as is humanly possible. Many investigators have already become aware of the extreme complexity of Soviet science and industry and the many difficulties attendant to the problem of solving the Soviet riddle. Perhaps the greatest obstacle, however, encountered by all American scientists and technicians is a lack of appreciation or knowledge of certain more or less intangible or little understood factors which are integral parts of Soviet development in all fields. Of vital and urgent importance are the answers to such questions as, - "How is it possible that the Soviets have been able to develop the 'A' bomb so rapidly?", "How is it possible that Soviet technology and industry have produced the MIG-15?" - and more specifically related to our present field of investigation, - "What conditions made the extensive mapping and geodetic programs of the U.S.S.R. during the past twenty years possible?". The answers to these and similar questions being asked by many intelligence, scientific, research and development groups in this country invariably are to be found, in whole or in part, in these so-called "intangible" factors.

Time, space, or scope of this project - or knowledge of or research by the staff of this project for that matter - do not permit exhaustive description of these intangibles. Indeed, except in so far as they specifically relate to the more or less definite problems of analysis of Soviet scientific achievements in geodesy, photogrammetry and cartography or in the technological phases of development in these fields, no report can be made on them at this time.

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A thorough knowledge of the educational and training programs of the U.S.S.R. is absolutely essential for complete and accurate evaluation of Soviet science or industry potential. A tendency to compare numerical statistics - U.S. ton to U.S.S.R. ton, U.S. ships or plans to U.S.S.R. ships or planes - has been carried over into the scientific field too often by some analysts. Such analyses fail to take account of the underlying significance of Soviet programs in the educational and training fields or to realize what has been and is still being accomplished in the matter of developing scientists and technicians in many fields. That geodetic or cartographic knowledge and "know how" in the United States equals or exceeds that of the U.S.S.R. may be a true statement. However, this fact, by itself, would be a most dangerous one on which to base our own future geodetic and cartographic programs, smug in the belief that ours is a superior ability. The really significant part involves the answers to such questions as, "Will the Soviets produce scientists capable of not only equalling the work of scientists of other nations, but who can also make those original contributions on which the further development of science and technology depend?" "How many scientists and technicians are being graduated in each field per year" "What are their educational and training requirements as compared with ours?" "What is the quality of their work?" "How many schools teach these subjects?" "What are the Soviet plans for future programs and what fields of science and technology are being emphasized, and why?".

The following report, date for which was obtained from open source material only, is an attempt to answer, at least in part, some of these questions as they pertain to the problem of evaluating and defining the Soviet potential in the fields of geodesy and cartography.

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SOURCES

Experience gained [redacted] during the last five years has indicated that certain general conditions always obtain in all phases of the study of Soviet science and technology. These conditions, described in detail in earlier reports [redacted] are sufficiently well-known now that exhaustive treatment and descriptions are unnecessary for the purpose of this report. Major items, however, may be stated briefly, as follows:

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1. Difficulties encountered in the collection of Soviet data.
   a. Incompleteness of U.S. library holdings of Soviet scientific books, serials, periodicals, etc.
   b. Lack of consistent library cataloging procedures.
   c. Lack of competent personnel, - translators, abstracters, or scientists who read the Russian language.
   d. High security classifications attached to several projects and materials dealing with the various phases of the Soviet problem have resulted, perhaps necessarily, in further complicating the collection of basic material.
2. Difficulties caused by the Soviet modus operandi.
   a. Lack of competent editing in Soviet publications.
   b. Existence of Soviet decrees pertaining to the dissemination of their scientific data.
   c. Frequent changes in names and character of research educational and production facilities, involving publications.

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d. Changes in scientific or scientific-political emphasis in the Soviet Union.

e. Difference between United States and Russian definition of "Science" (Nauka) and associated differences in classifications of sciences, educational and research programs.

Items (a) and (b) apply to all scientific effort in the Soviet Union. Items (c) and (e) also always apply but, of course, vary considerably in detail with the particular sciences under investigation.

3. Difficulty in distinguishing between and categorizing research, training, and industrial facilities, along with associated personnel and publications.

Tedious and painstaking work over an extended period by many hundreds of individuals, both here and abroad has resulted in the collection of a considerable amount of information on various aspects of Soviet science. Various groups and agencies have prepared partial or complete translations and abstracts. This report will attempt to correlate and digest all open-source materials made available to the Laboratory or discovered by its own staff, which pertain to the fundamental problem of scientific education and training in the Soviet Union with specific emphasis on educational programs in the fields of geodesy and cartography.

Perhaps one of the most obvious and consistently representative statements that can be made concerning the availability of scientific source materials is that, prior to the year 1941, detailed information of both a theoretical and specific nature was available to all those who sought and read it. Publications of nearly all types could be had for the asking. From reports of this period (1919-1940 inclusive) a rather complete history

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of the development of theoretical and applied science and educational programs, curricula, etc. can be reconstructed. After 1940 (1941-1947) there followed a period in which Soviet science went through considerable political and scientific change, new programs resulted from war experiences and sciences not previously supported by the government received new impetus. Some curtailment in the amount of scientific and educational work resulted, although not to the extent that might have been expected as a result of occupation, destruction and re-location. During this period, publications of a scientific nature, though still available to this country, were not obtained in as great abundance here and those that were available were of a less specific and comprehensive nature.

The most serious hiatus, however, resulted from the Russian ban on the export of all scientific data affecting defense in 1947. From this time to the present, specific scientific data are almost entirely lacking. That information which has been obtained by us is of a general or theoretical nature, and is fragmentary and often contradictory or otherwise confusing. Additional data published between 1941 and the present continue to trickle into this country. As more and more of this information becomes available, some of the uncertainties mentioned in this report may perhaps be removed.

For the period prior to 1941 the best source of information on geodetic and cartographic programs and methods is the Russian professional journal, "Geodezist", which contains many articles on the subject of training and research as well as the chronicle of events in the system of the Main Administration of Geodesy and Cartography (Glavnoye Upravleniye Geodezii i Kartografii and denoted as GUGK henceforth in this report). The military counterpart of the GUGK, the Military Topographic Administration (Voyenno-Topograficheskoye Upravleniye, VTU) also participated in the publication

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of the "Geodezist", although even before the war very little was being published on the activity of the VTU in the "Geodezist" or elsewhere. In December 1940 this journal was discontinued and was supplanted by the "Sbornik Nauchno-Tekhnicheskikh i Proizvodstvennykh Statey po Geodezii, Kartografii, Aeros"yemke i Gravimetrii" (Collection of Scientific Technical and Production Articles on Geodesy, Cartography, Aerial Survey and Gravimetry, henceforth as Sbornik NTPS) published by the GUGK alone. Simultaneously the VTU began publishing its own Sbornik (Voyenno-Topograficheskiy Sbornik). No definite statement has been found to date as to the reasons for this change. However, so far as we are concerned, the change was for the worse since articles are much less detailed and the chronicle of events is almost absent.

Another valuable source of information for the period up to 1940 is the two-volume work, "XX Let Sovetskoy Geodezii i Kartografii", (20 years of Soviet Geodesy and Cartography) published in 1939 in which detailed reviews of various branches of geodesy and cartography are given.

After 1940 we must rely on the less comprehensive information published in the Sbornik NTPS as well as information found in reference-books, textbooks, encyclopedias, miscellaneous periodicals, monographs, etc., to which reference is given in the text of this report.

I. EDUCATION AND TRAINING IN GENERAL

Training in geodesy and cartography is part and parcel of the comprehensive Soviet system of training and it is necessary before we treat the specific problems of geodesy and cartography to say something about the system as a whole.

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The central theme of Soviet education has always been the "kadry". The importance of the "kadry", (that is, cadres) scientific and technical personnel, was realized by Lenin immediately after he assumed power. Imperial Russia was relatively poor in scientific and technical personnel. Moreover, much of the existing pre-revolution personnel was opposed to the Communistic government and therefore was either annihilated or driven abroad. Lack of suitable personnel made speedy recovery and industrialization of the country after the ravages of World War I and the revolution very difficult. In fact, it appears that only the liberal employment of foreign engineers and technicians saved the situation. However, the Soviet government clearly realized that it could not depend forever on foreign help and very consistently carried forth a program of providing the country with native expert personnel. A most striking expresession of this attitude was given by Stalin in his report to the 17-th Congress of the Communistic Party, January 26, 1934. Speaking of the development of Soviet industry the preceding three years, he said:

"But of all achievements of industry during the period covered by this report we must count as the most important achievement our success in educating and training thousands of new workers and new leaders of industry. We have produced a whole new generation of engineers and technicians and hundreds of thousands of qualified workers who have mastered the new technology and advanced our socialistic industry. There is no doubt that without these people our industry could not achieve the results of which we are so proud. We have the data to show that during this period factory and mill schools produced 800,000 more or less qualified workers, and universities, technological schools and technicums graduated more than 180,000 engineers and technicians. If it is true that the problem of the cadres is the most ser-

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ious problem of our development, we must admit that our industry is beginning to solve this problem."

This is not a chance quotation from Stalin. One can collect dozens of similar quotations from his speeches, as well as from speeches of other leaders of the U.S.S.R. With such an attitude prevalent in the ruling circles, rank and file educators took up the theme and published innumerable books on general and technical education in which the experience of other countries was analyzed, criticized and compared with the U.S.S.R. experience. There were (and perhaps still are) several periodicals specifically devoted to the problem of the cadres, such as "Za Promyshlennyye Kadry" (For industrial Cadres), "Kadry Sovetskoy Promyshlennosti" (Cadres of Soviet Industry), etc.

The general features of the scientific and technical personnel in the U.S.S.R. may be summarized as follows:

(a) The social position of scientists or technicians in the U.S.S.R. is extremely high. They are the elite of the country regardless of their political faith so long as they do not commit an overt act hostile to the regime. During the war they were given special privileges in regard to food, clothing, shelter, etc. Many of them were exempted from military service. During the siege of Leningrad young scientists were evacuated to Lake Ladoga, while the rest of the population was left to starve.

The government evidently takes the attitude that scientists and engineers are of the greatest importance to the national economy. Yet the slightest criticism of communism is severely punished regardless of the status of the scientist. This was especially true during the great purges of 1935-37 when many outstanding scientists were shot.

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(b) There is a very elaborate and apparently effective system of supplementary training no matter how high the position of the scientist is, such as refresher courses, periodic reviews of activity, etc. No scientist or engineer is allowed to "go to seed".

(c) There is a very efficient system of competition in science and technology, excellence of performance being highly rewarded by various prizes, medals, decorations, etc.

(d) Teaching and research in science and technology are very closely connected. In various universities and instructional institutes a great deal of research is being done. In many purely research institutes some training is offered in post-graduate work.

(e) All research, teaching and training is closely connected with political life. There is no such thing as neutral science.

The organization of Soviet education and technical training is a very complex subject not to be fully explained in a few pages of a report. We can hope here to give only enough background for the discussion of training in geodesy and cartography in Soviet institutions. Comparison of Soviet sources of 1946 and 1950 shows that considerable changes in Soviet education took place in this interval, and undoubtedly are still taking place.

In general, the Soviet system of training has three subdivisions:

1. Nachal'naya Shkola, (the "Beginning" School) more or less equivalent to the American Elementary School.
2. Srednyaya Shkola, (literally the "Middle" School) the last four years of which may be considered as equivalent to the American High School.
3. Vysshaya Shkola, (literally the "Higher School) of university and college level.

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SYSTEM OF TRAINING

U.S.S.R.

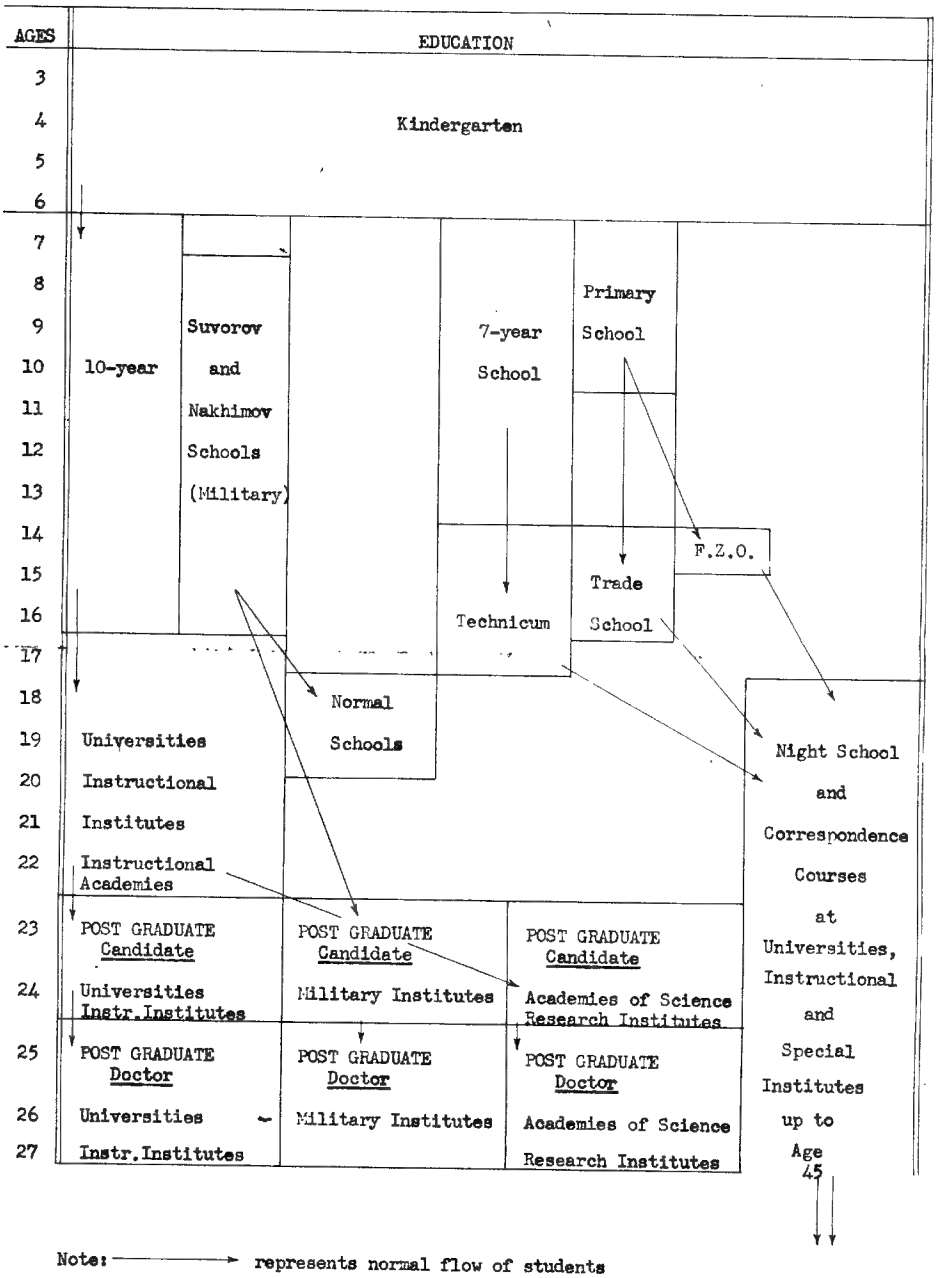

FIG. I

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There are, however, in the U.S.S.R. many schools for which no precise American equivalent can be found. In this category for instance, are the technicums (about 3,500) which exist for almost every industry and technology which the Soviets include in the system of Srednyaya Shkola.

Fig. 1 shows the various types of schools in the Soviet Union, the age groups represented in each, the political unit to which each age group is assigned, and the normal flow of students from one type of school to another.

A. LOWER EDUCATION

The level of compulsory education in the U.S.S.R. in 1946 was the elementary school of four years for children of 7 to 10 years of age. However, this level was supposed to have been raised to the seven year school; that is, up to the age of 14. In 1946 this educational level was obligatory in cities and towns, but apparently not in the whole country [1].

In this report we are concerned only with those aspects of lower education which supply skilled workers for factories and industrial establishments. After a very complicated history involving many stages and plans for the training of skilled workers the Soviets have finally developed a system known as the FZO (Fabrichno-Zavodskoye Obucheniye); that is, Factory and Mill Training). A special ministry, Ministerstvo Trudorvykh Rezervov (Ministry of Labor Reserves)*, is in charge of the FZO, and publishes a periodical, "Proizvodstvennoye Obucheniye" ("Production Training").

* Ministry of Labor Reserves since March 15,1953 is in the new Ministry of Culture (Ministerstvo Kul'tury).

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Adolescents of 15-16 years of age not attending the regular high school or any other specialized school, are drafted for a period of from half-a-year to one year depending on the character of the training. They are assigned to training schools at factories and mills, are supported by the government and, after graduation, distributed according to their specialties.

In addition to the FZO schools, there are two other types of schools also administered by the Ministerstvo Trudovykh Rezervov. They are:

(a) Remeslennyye Uchilishcha (Trade Schools) with a two-year training period for every line of technology and industry.

(b) Zheleznodorozhnyye Uchilishcha (Railroad Schools) with a three-year period of training.

Up to 1946, some 4,530,000 workers had received this training. The demand for qualified workers was still so great that the entire program was accelerated and, for the fourth Five-Year Plan, the following norms were adopted:

1946	450,000	to be trained as skilled workers.
1947	760,000	
1948	980,000	
1949	1,090,000	
1950	1,250,000	
Total	4,530,000	workers.

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B. INTERMEDIATE EDUCATION IN GENERAL

In addition to the ordinary middle school (Srednyaya Shkola) there are in the U.S.S.R. numerous schools of specialized training known as "tekhnikumy" (Technicums), "uchilishcha" and "shkoly" (both latter terms meaning schools). Generally speaking, technicums give technical and agricultural training, uchilischa offer instruction in education and art, and shkoly in public health. However, there are many exceptions to this rule.

General supervision of this system is given by the Ministry of Higher Education, but financial and administrative aspects are handled by the corresponding ministries and directorates.

Young people enter these schools with a seven year record of middle school; that is, at the age of 14-15. The term of instruction is from 3 to 4 years. However, students with a complete middle school record of 10 years may also enroll in a technicum. In this case, the length of instruction is abbreviated to two years.

Nothing definite can be stated as to the status of these schools. The situation varies considerably in different branches of science and technology. The eleven technicums in the system of GUGK are discussed in detail later in this report. The conclusion derived from a study of these is that they are certainly above the level of the American high school and correspond better to the American Junior College of specialized training. Whether this statement is true of technicums in general is impossible to decide without detailed study. It is to be noted that the Srednyaya Shkola is administered by the Ministry of Enlightment, whereas technicums, etc., belong to the system controlled by the Ministry of Higher Education. Therefore, it would seem that the Russians themselves

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consider technicums as of a somewhat more higher level than ordinary high schools.

The purpose of technicums is to supply technicians to carry out work under the direction of engineers. Soviet educators assert (Medynskiy, ref. 1, pp. 157-158) that intermediate technical education is not a blind alley out of which there is no exit. A graduate of a technicum can, for instance, enter an institution of higher education by passing a special examination after serving three years in the practice of his specialty. Especially talented young people (up to five percent of the total) may be released from this compulsory service to institutions of higher education immediately after graduating from a technicum. (See Appendix B).

The list of technicums, uchilishcha and shkoly as of 1948 is [2] as follows:

		Number of Technicums
1.	Mining and Fuel Industry	96
2.	Metallurgy	58
3.	Power and Electrical Engineering	167
4.	Chemical and Rubber Industry	34
5.	Light and Textile Industry	56
6.	Food Industry	110
7.	Lumber and Paper Industry	53
8.	Labor Reserves	21
9.	Polygraphic Industry	4
10.	Construction	151
11.	Transport	148
12.	Communications	19
13.	Geology, Geodesy and Meteorology	21
14.	Industrial Technicums of Various Types	51
15.	Agriculture	550
16.	Forestry	22
17.	Economics and Law	235
18.	Education	701
19.	Cultural - Educational Institutions	73
20.	Art and Crafts	194
21.	Public Health	635
22.	Physical Culture	43
	Total	3,442

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C. HIGHER EDUCATION

According to the latest data [3] there were 849 institutions of higher education (Vysshaya Shkola) in the U.S.S.R. in 1950 and 885 in 1952. Another source,[4] gives for 1946 only 792 institutions. This means that in a six-year period the number of institutions of higher learning in the U.S.S.R. increased by 93. This is a very significant fact requiring no further comment.

None of these sources mentions the institutions of higher learning connected with various defense and military organizations. There are at least 30 of these.

The primary task of all of these institutions of higher education is, of course, instruction and training of students. Nevertheless, considerable research is also being done, obviously differing in amount and quality from institution to institution. The main decree pertaining to research work at the institutions of higher education is that of SNK* of February 18, 1944, No. 178, supplemented by several others. This decree defines the purpose of research work as follows:

(1) Development in the institutions of higher learning of scientific personnel who are not afraid to depart from the old, conventional, scientific methods and who are able to strike out in new directions.

(2) Participation of professors in research necessary for national economy and defense of the country and in further progress of science and culture in the Soviet Union.

* Soviet Narodnykh Komissarov - Council of Peoples Comissars, now the Council of Ministers.

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(3) Improvement of scientific status of professors.

(4) Instruction of students in the formulation and solution of scientific and technical problems and the selection of the most promising students for research work.

There are many forms of encouragement given for research work performed at institutions of higher learning, such as prizes, citations, additional remuneration, etc. The general idea seems to be to prevent professors from scientific stagnation and make them participate in the scientific and industrial life of the entire country.

Decree No. 2000 of SNK dated November 1, 1937, defines the normal working day for the teaching staff of institutions of higher learning as six hours. Out of these six hours professors and teachers depending on this status must devote from 2.25 to 3.50 hours to working with students with remaining time to be devoted to research and improvement of teaching.

There is no question that research in institutions of higher education is encouraged in every way by the government. There is also no question that in some institutions a great deal of research is being done as is evidenced by the fact that many such institutions publish their own serial or serials. Some of these, such as the publications of the Moscow and Leningrad Universities, are very imposing. However, it may well be that even with the best of intentions professors simply cannot find time for research because of the demands of their primary responsibility of teaching.

Recent discussions in Russian literature distinctly indicate that the amount of research done in the institutions of higher learning is not

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as great as envisaged by the government. For instance, in discussing the training of geographers at universities, V.N. Sementovskiy [5] states that duties connected with teaching take 80 to 90 percent of a professor's time, not the 50 percent planned. For research an average professor has only 10 to 20 percent of his time. On the other hand, N. I. Aleksakov,[6] reviewing the situation at the Moscow Institute of Mechanical Engineers, comes to the conclusion that lack of research simply means lack of organization. Describing measures taken to increase research at his institute, he states that in 1948 scientific personnel had been working on only four topics, but that in 1951-54 research projects were underway.

The detailed organization of these numerous institutions of higher education underwent many changes during the 1917-1950 period. At present the most important institutions are under the supervision of the Ministry of Higher Education, U.S.S.R. (Ministerstvo Vysshego Obrazovaniya, SSSR).* This Ministry has eleven main administrations (Glavnoye Upravleniye) to which the corresponding institutions are assigned. Thus 33 universities and six institutes are in the Main Administration of Universities, etc. For the year of 1950 they were divided as follows:

Administration of	No. of institutions
1. Universities	39
2. Polytechnical Schools	25
3. Machine Building Schools	28
4. Mining and Metallurgy Schools	22
5. Chemical Technology Schools	17
6. Civil Engineering Schools	23
7. Light Industry Schools	8
8. Forestry and Wood Techn. Schools	12
9. Agricultural Schools	71
10. Economic Schools	27
11. Law Schools	10
Total	282 Schools

* In the reorganization of March 15, 1953 Ministerstvo Vysshego Obrazovaniya was combined with two other ministries and various other organizations into a new ministry known now as Ministerstvo Kul'tury (Ministry of Culture).

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There are many other ministries and administrations in the U.S.S.R. as well as ministries of individual republics to which other institutions of higher education are assigned. Of these, at least from the point of view of numbers, ministries of enlightment to which 377 pedogogical and teachers institutes are assigned (in 1952), and ministries of health which account for 74 medical institutes (in 1952), are especially important. Regardless of what Ministry the educational institution is listed under, the Ministry of Higher Education exercises definite control over programs of instruction, the general educational setup and especially in the award of advanced degrees.

In contrast to this network of educational institutions there are some 1,000 research institutes whose primary, and often the only, activity of the staff is research. Such institutes are attached to the

(a) Academy of Sciences U.S.S.R., or to the Academies of Sciences of individual republics. In this system alone there are some 200 research institutes, the main Academy accounting for something like 60 institutes.

(b) Other Academies (such as the Academy of Agricultural Sciences) and universities.

(c) Individual ministries, independent bureaus and directorates. The research institute attached to the Main Administration of Geodesy and Cartography is known as the Tsentral'nyy Nauchno-Issledovatel'skiy Institut Geodezii, Aeros"yemki i Kartografii (that is, Central Scientific-Research Institute of Geodesy, Aerial Survey and Cartography). The organizational scheme of such institutes is a very difficult thing to unravel due to frequent changes and lack of recent Soviet sources. In 1935

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for instance there were 127 research institutes in the Comissariat of Heavy Industry. This comissariat was replaced in 1946 by a number of ministries and the institutes were accordingly redistributed. It should be noted that research institutes connected with various ministries of defense have only identifying numbers and not even names. Such, for instance, is Research Institute No. 108 which was attached in 1946 to the Comissariat of Electrical Industry. The highest number so far encountered is No. 627, also assigned to the Ministry of Electrical Industry. The whole problem of numbered research institutes is part of the system of secrecy in science and technology which is much more striking in the U.S.S.R. than in any other country. One might say that science in the U.S.S.R. is an iceberg, the larger part of which is hidden from sight. Conversation with recent refugee scientists indicates that almost any research institute would have a secret department, the work of which is not known to the general staff of the institute. Indeed, references are made to this secret work in official publications. Projects are sometimes listed in which work has been carried out but the results withheld from publication.

The Ministry of Higher Education exercises control over some research institutes, regardless of their affiliation, through a system of advanced academic degrees and professional titles. This is done through the Vysshaya Attestatsionnaya Komissiya (Supreme Attestation Committee) of the Ministry.

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By decree No. 464, of March 20, 1937 the following academic degrees were established:

(1) Candidate of Science, approximately equivalent to the American Master's Degree.

(2) Doctor of Science, approximately equivalent to the American Ph.D.

These degrees can be taken in 18 specified branches of study, the official designation being not simply Doctor of Science, but Doctor of Technical Sciences, Doctor of Geographical Sciences, etc.

People (aspirants) working for the advanced degrees are assigned to various specified institutions of higher learning as well as to some research institutes. The list of these institutions and research institutes is given in decrees of SNK No. 464 and No. 558. In 1946 there were 216 institutions which could grant degrees of both candidate and doctor, and 130 which could grant only the degree of candidate. The number of these institutions is rapidly increasing. From a report [7] on the activity of the Vysshaya Attestatsionnaya Komissiya for the academic year of 1949-50, it is seen that the number of institutions in the first group was 470 and in the second, 278.

The fact that the university or research institute does not award the Doctor's degree, but merely recommends its awarding which is actually done by the Vysshaya Attestatsionnaya Komissiya, is also noteworthy. On the other hand, the award of the Candidate's degree is made by the institution in which the study was carried out, but must be confirmed by the Vysshaya Attestatsionnaya Komissiya.

In 1949-50 the Vysshaya Attestatsionnaya Komissiya conferred 484 Doctor's degrees and 4,536 Candidate's degrees were awarded by different institutions.

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Rules governing training for advanced degrees (aspirantura), lists of institutions and specialties in which aspirants may work for a degree, etc., may be found in a special publication [6].

Decree No. 464 also establishes professional titles in a two-fold sequence, one for institutions of higher education and the other for research institutes. They are as follows:

Institutions of Higher Education	Research Institutes	Qualifications
Professor	Professor	Doctor's degree
Dotsent	Starshiy Nauchnyy Sotrudnik (Senior Scientific Aide)	Candidate's degree
Assistent	Mladshiy Nauchnyy Sotrudnik (Junior Scientific Aide)	Diploma Showing Completion of Higher Education.

The title of Professor, Dotsent and Starshiy Nauchnyy Sotrudnik are conferred by the Vysshaya Attestatsionnaya Komissiya upon recommendation of the institution of higher education or of the research institute. The other titles are conferred by the particular institutions to which the person is attached. In 1949-50 the Commission conferred the titles:

Professor	571
Dotsent	1811
Starshiy Nauchnyy Sotrudnik	1546

This description, of course, does not give the complete picture of the Soviet educational and research organization. Besides the official titles described above there are many employees who are simple called teachers (prepodavateli) of various types as well as special assistants.

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The peculiar difficulty in following careers of Soviet scientists is the fact that they are connected with several organizations. One and the same person may be listed on the staff of half a dozen institutes. This is to be explained by the low pay of professors who had to have several jobs in order to stay alive as well as by the rapid expansion of the educational and research institute system and consequent lack of qualified personnel.

However, with the introduction of a standardized system, this multiple employment is to be permitted no longer according to the decree of March 6, 1944. It would appear that the Soviets consider that they have finally solved the problem of sufficient scientific personnel.

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II. CARTOGRAPHIC AND GEODETIC INSTRUCTION

Cartographic and geodetic training in the U.S.S.R. is offered in such general schools of higher education as universities and technical institutes as well as in specialized schools of geodesy and cartography. The difference in the point of view between these two types of schools is the emphasis on theory in the first and on practical applications in the second.

At universities the larger subdivisions are known as "faculties" (fakul'tet) each of which has a number of "chairs" (kafedra). The chair consists of a chairman, usually a senior professor with a doctor's degree, and a number of other professors, dotsents, teachers, etc. Generally, cartographic instruction is given in the faculties of geography, instruction in geodesy in the physical-mathematical faculties. Detailed data concerning university training in geography is available, but our information pertaining to geodesy is less voluminous. Although it is probable that some instruction in geodesy is given at all universities, only two of them (Voronezh and Leningrad) are listed as offering advanced degrees in that science. In addition, three universities (Moscow, Kazan' and Leningrad) offer advanced degrees in gravimetry.

A. UNIVERSITIES

The search for data concerning the training of geographers in the U.S.S.R. takes us back to 1884 when geography first began to be taught at universities. In 1910 at St. Petersburg a Geographical Bureau was established to coordinate the teaching and research in geography. In 1916 an Institute of Geography was opened in St. Petersburg and existed until 1924 when it became the Geographical Faculty of Leningrad University. Even then

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the institute was a very large organization. In 1920 it had 16 chairs, 22 laboratories and 715 students [10]. At the present time there is no special institute of geography for training of students outside of universities. It is interesting to note that the re-establishment of such a central institute is now advocated [11].

The contribution made by universities toward the mapping and charting of the U.S.S.R. can by no means be neglected. They train teachers of geography for schools of higher education, research workers for the Academies of Sciences and research institutes, as well as professional cartographers for organizations engaged in mapping activities. In addition to training of students, an impressive amount of research is being done at universities on the problems of geography, cartography and astronomy in its geodetic application.

The necessity for employment of trained and experienced geographers to collect and edit cartographic materials was realized as early as 1924, and in 1936 professional geographers were added to the staff of various aerogeodetic establishments. Since then several orders have been issued by the GUGK finally culminating in No. 321 order of October 29, 1945. This order defined the character and contents of geographic work in connection with the mapping of the territory as follows [12]:

The work of the geographer would consist of

(1) Preparatory investigation, collection of available materials, etc.

(2) Field work for the purpose of interpretation of aerial photographs, editing of maps and compilation of geographic descriptions.

(3) Collection and transcription of geographic names.

(4) Laboratory interpretation of aerial survey material.

(5) Editing of compiled sheets.

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(6) Preparation of geographic descriptions.

In regard to the last item it should be noted that by order No. 101 of the GUGK of May 9, 1944, geographic descriptions must accompany all topographic surveys and be uniformly arranged according to headings on climatology, geology, relief, hydrography, soil and vegetation and animal life. Source (12) states that in 1948 all aerogeodetic establishments possessed a large number of such descriptions.

Soviet writers maintain that the training of geographers can be done only at universities. Indeed, one of the resolutions of the conference of senior workers of the GUGK on May 23-26, 1945 called on universities to establish the necessary facilities to train geographers required by the GUGK [13].

Although exact data are unavailable, the number of geographers directly connected with the GUGK must be rather large, at least 100. In 1945 there were five geographers at the Moscow Aerogeodetic Establishment. This number was considered to be "utterly inadequate"[14]. Even in 1945 the total number of geographers in the system of the GUGK, judged by the above figure, must have been 50 to 60. In addition, it is known that other mapping agencies such as the Voyenno-Topograficheskaya Sluzhba (Military Topographic Service), the Glavsevmorput' (Main Administration of the North Sea Route) and many other local agencies employ geographers for cartographic purposes. Therefore, it is probable that the total number of such geographers may be at least 500, and probably many more.

Can the country furnish so many professional geographers? There cannot be much question that it can and does, although exact figures of enrollment and staff at individual universities are not available. We do know, however, that 1,113 degrees in geography were granted at Moscow University during the

[redacted]

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period of 1917-1950. Of these, 478 were conferred during the last five years or approximately 100 per year. In 1950 5,250 students were enrolled in the faculties of geography of all universities. The annual output of geographers must be then in the neighborhood of 1,000 per year [15]. It is to be remembered that the period of training in Soviet universities is now five years.

These estimates are in fair agreement with those of the attendance at the 2nd All Union Congress of Geography, January 25-31, 1947. At this meeting 544 delegates attended, 90 percent of whom were university teachers or research workers. Among these were 34 members of the Academies, 140 doctors of science and 226 candidates of science. The present membership of the All Union Geographic Society is over 4,000, most of whom are professional geographers.

Sofar as the university training of geographers is concerned we must distinguish two cases: simple instruction in geography and intensive training. The latter case is indicated by the existence of "specialties" in geographic sciences and usually means that students can work for the advanced degrees of candidate or doctor at such schools.

Statistics concerning the university training of geographers are noteworthy. Of the 33 universities in the U.S.S.R., 27 offer geographic training in six general specialties. The following table gives the notations adopted for these specialties:

Specialties	Specializations
1. Physical Geography	a. History of Geography b. Physical Geography c. Geography of Polar Regions d. Geography of Soils e. Geography of Plants f. Geography of Animals

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2. Economic Geography	a. Economic Geography U.S.S.R. b. Economic Geography of Foreign Countries.
3. Cartography	
4. Climatology and Meteorology	
5. Hydrology	a. Hydrology of Land b. Oceanography
6. Geomorphology	

Specialties 1, 2 and 5 are further broken into several specializations of which Moscow University offers all, exception specialization 1_f and Leningrad University offers all, except specialization 1_e.

A recent discussion by one of the most outstanding cartographers in the U.S.S.R. is available[16]. It discusses the entire problem of training cartographers in the U.S.S.R. The author maintains that the training given to future cartographers at special institutions such as the Moscow Institute of Engineers of Geodesy, Aerial Survey and Cartography produces good technicians able to make a good map if furnished the necessary material but that the selection and analysis of material can be done only by geographers trained at universities. The difference, then, between the two types of training is that of form and content.

We have at our disposal the official handbook [3] for entrants to the Soviet institutions of higher education of edition 1950 and 1952. A comparison of these two editions reveals many changes indicating lack of stability of Soviet educational system. Many new schools were established in these two years, others changed their names and programs.

Sofar as the universities are concerned, there were 32 of them in 1950 and 33 in 1952. Between 1950 and 1952 the Kaunas University became Kaunas Polytechnical Institute, and two new universities were organized: Kirgizskiy

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(in Frunze) and Turkmenskiy (in Ashkhabad).

The training in geography in Soviet universities is given either in special faculties of geography, or in faculties combining geology and geography (Geologo-Geograficheskiy Fakul'tet). At two universities (Vil'no and Tartu) students can become specialized in geography in the faculties of natural science. The trend in geographic training between the years 1950 and 1952 can be represented by the following table:

TRAINING IN GEOGRAPHY IN SOVIET UNIVERSITIES

	1950	1952
Separate Faculties of Geography	18	14
Combined Faculties of Geology and Geography	6	11
Other Faculties	2	2
Total	26	27

It would seem that geography is not as strongly emphasized in 1952 as in 1950, but very little can be asserted on the basis of this table alone. The combination of geology with geography is quite natural, and such subjects as geomorphology, considered by the Soviets as a geographic discipline, can as well be included in the cycle of geological sciences. However, further comparison of the sources of 1950 and 1952 indicates rather definitely that the training in geography was not as well provided for in 1952 as in 1950. The data of these two sources are combined in Table I. It includes 28 universities of which one (Uzbekskiy, No. 21) ceased to offer specialty in geography between 1950 and 1952. Those universities that had separate faculties of geography in 1952 have an asterisk after their number. In the list of specialties those abolished by 1952 are put in parenthesis. Furthermore, for many univer-

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sities the specialties physical geography and economic geography, distinguished in 1950, are called simply "geography" in 1952. For such cases specialty No. 2, physical geography, has an interrogation sign.

The most remarkable reduction of training is in cartography. Instead of nine universities offering this specialty in 1950, only five continued to do so in 1952. The reason for this situation could not be established. It may indicate an abundance of cartographers produced by the professional schools, or simply lack of competent instructors.

TABLE I

SPECIALTIES IN GEOGRAPHY
1950-1952

University	Specialties					
	1	2	3	4	5	6
1. Azerbaydzhanskiy (Baku)	*	?*				
2. Belorusskiy (Minsk)	*					
3.* Voronezhskiy (Voronezh)	*	?*	(*)	(*)	*	
4. Dnepropetrovskiy (Dnepropetrovsk)	*	?*				
5.* Yerevanskiy (Yerevan)	*	*				
6. Irkutskiy (Irkutsk)	*	?	(*)			
7.* Kazanskiy (Kazan')	*			*		(*)
8. Kazakhskiy (Alma-Ata)	*	?*				
9.* Kiyevskiy (Kiyev)	*	*	*	*	*	*
10.* Latviyskiy (Riga)	*	?*				
11.* Leningradskiy (Leningrad)	*	*	*	*	*	*
12.* L'vovskiy (L'vov)	*	*				
13. Molotovskiy (Molotov)	*	?	(*)		*	*
14.* Moskovskiy (Moscow)	*	*	*	*	*	*
15. Odesskiy (Odessa)	*	?*		*	*	
16. Rostovskiy (Rostov)	*	?*				
17.* Saratovskiy (Saratov)	*	*	*	*		*
18.* Sredneaziatskiy (Tashkent)	*	?*	(*)		*	
19. Thilisskiy (Tbilisi)	*	?*		*	*	*
20.* Tomskiy (Tomsk)	*	?*		*	*	
21. Uzbekskiy (Samarkand)	(*)					
22.* Ural'skiy (Sverdlovsk)	*	?*	*			
23.* Khar'kovskiy (Khar'kov)	*	?*				
24.* Chernovitskiy (Chernovitsy)	*	*	*	*	*	*
25. Vil'nyusskiy (Vil'nyus)	*	?				
26. Tartuskiy (Tartu)	*	?				
27. Kirgizskiy (Frunze)	*	?				
28. Turkmenskiy (Ashkhabad)	*	?				

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The most striking characteristic of Soviet geography, as of Soviet science in general, is its directness, a directness toward a single goal. Many samples may be offered to illustrate this point. At the above mentioned 2nd All Union Geographic Congress almost every paper (of which there were over 200) dealt with specific applications of geographical methods for mapping of natural resources, exploration of marginal territories, cartography, etc. Special emphasis is placed on the interaction of man and nature, and pointed toward Soviet attempts better to control nature. Volume 23 of the serial, "Voprosy Geografii" (1950), is devoted entirely to the subject of "Nature of the Steppes and of Forest-Steppes and its Transformation." The theme appears to be to define the role of geographers in this national project. The Institute of Geography of the Academy of Sciences, U.S.S.R., is bitterly criticized for its detachment from this problem of the control of nature.

The character of training in geography given at universities is best known for Moscow University. Here emphasis is on practice. Large and small expeditions are sent to all parts of the country. After the war these included large expeditions to Eastern Siberia, the Caspian Depression and the Central Chernozem Region. The results of these expeditions were published as follows:

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Eastern Siberia - 12 papers, totaling 500 pages.

Caspian Depression - 12 papers, totaling 400 pages.

Central Chernozem Region - 15 papers, totaling 1,000 pages.

In 1950 16 aspirants, 127 senior students and 55 members of the staff participated in these expeditions. Response of local agencies to the results of such expeditions appears to be quite enthusiastic. In 1949 the ispolkom (governing body) of Irkutsk Oblast' petitioned the Ministry of Higher Education and the Moscow University administration to allow the Geographic Faculty of the university to continue its work of exploration in that province "since the complex study of nature and economy carried out by university expeditions is necessary for the rapidly expanding industrial economy of Eastern Siberia" [11].

Much the same picture of activity could be drawn for the Faculty of Geography at Leningrad University, although perhaps on a somewhat smaller scale.

The relative strength of various geographical faculties can be judged by their right to accept aspirants for the degree of doctor or candidate of science. The list of subjects in which aspirants can do work reads somewhat differently from the list of specialties given in Table I. The following (Table II) represents information extracted from source (8) of 1949 and gives a list of universities authorized to give training for both doctor's and candidate's degree (D) in specified subjects or only the Degree of Candidate (K). The number gives to each university is the same as that of Table I.

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TABLE II

ADVANCED DEGREES IN GEOGRAPHY AND RELATED SCIENCES

1.	Azerbaydzhanskiy	K:	Physical Geography; Economic Geography
2.	Belorusskiy	K:	Physical Geography; Economic Geography
3.	Voronezhskiy	D:	Economic Geography
		K:	Climatology; Cartography and Geodesy
7.	Kazanskiy	D:	Physical Geography; Gravimetry
		K:	Climatology
9.	Kiyevskiy	K:	Physical Geography; Economic Geography
10.	Latvivskiy	K:	Geography of U.S.S.R.; General Physical Geography
11.	Leningradskiy	D:	Physical Geography; Economic Geography; Botanical Geography; Geomorphology; Hydrology of Land; Cartography; Climatology; Oceanography; Geodesy and Gravimetry
12.	L'vovskiy	K:	Physical Geography
13.	Molotovskiy	K:	Physical Geography
14.	Moskovskiy	D:	Physical Geography; Economic Geography; Cartography; Gravimetry
16.	Rostovskiy	K:	Economic Geography
17.	Saratovskiy	K:	Physical Geography; Economic Geography
18.	Sredneaziatskiy	D:	Physical Geography; Economic Geography
19.	Tbilisskiy	D:	Physical Geography; Economic Geography
20.	Tomskiy	K:	Physical Geography; Economic Geography
23.	Khar'kovskiy	K:	Physical Geography; Economic Geography
25.	Vil'nyusskiy	K:	Physical Geography
27.	Mosk. Ped. Institut im. Potemkina	D:	Physical Geography; Economic Geography
28.	Mosk. Ped. Institut im. Lenina	D:	Physical Geography; Economic Geography

Except for the scale the structure of the Geographical Faculty of Moscow University is probably typical of all universities. The faculty consists of 14 chairs under chairmen who are not necessarily the strongest specialists in the subject. Each chair has, in addition to a chairman, four or five professors, dotsents or teachers. The total number of persons in the teaching and research staff was 95 in 1950. The faculty is headed by the dean (K. K. Markov) who is also chairman of the paleogeography section.

In 1949 there was the following organization of the Geographic Faculty of Moscow University [17].

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1. General Physical Geography (Professor B.P. Orlov).
2. Physical Geography U.S.S.R. (Dotsent A.I. Solov'yev)
3. Physical Geography of Foreign Countries (Professor A.S. Barkov)
4. Economic Geography of the U.S.S.R. (Professor Yu. G. Saushkin)
5. Economic Geography of Foreign Countries (Professor I.A. Vitver)
6. Geomorphology (Professor I.S. Shchukin)
7. Geodesy and Cartography (Dotsent P.V. Denzin)
8. Hydrology (Professor S.D. Muraveyskiy)
9. Climatology (Professor B.P. Alisov)
10. Botanical Geography (Professor V.N. Sukachev)
11. Geography of Soils (Professor I.P. Gerasimov)
12. Paleogeography (Professor K.K. Markov)
13. Geography of the Arctic (Professor V.G. Bogorov)
14. History of Geography (Professor K.A. Salishchev)

The faculty of geography also includes a research institute of geography (Nauchno-Issledovatel'skiy Institut Geografii) and three geographic stations for student training.

The relationship between the research institute and the faculty of geography is not quite clear. Apparently, personnel is much the same for both with a few additional people assigned to the institute with research duties only. Of the 65 participants in expeditions of the Moscow University organized by the faculty of geography and by the research institute, 13 hold the title of "sotrudnik", implying research duties only [18].

Detailed information on the structure of geographic education is not as available for Leningrad University as it is for Moscow University. In a discussion of the work of the faculty of geography at Leningrad [19] 17 members of the faculty are mentioned. The total number of the members of the faculty must, therefore, be more than 17, perhaps 30 or 40, but, at any rate, smaller than at Moscow. The dean of the faculty is Professor S.S. Kuznetsov. The Leningrad faculty of geography has its own research institute known as "Geografo-Economicheskiy Institut", the work of which apparently emphasizes economic geography. One of the participants in the discussion was a "Starshiy Nauchnyy Sotrudnik" (Senior Scientific Aide), a research title.

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The problem of geographical education in the U.S.S.R. is apparently now quite acute. The Ministry of Higher Education established a commission to look into the matter and some of its recommendations are available [15]. One difficulty is undoubtedly the lack of qualified personnel to give proper instruction to so many students. In 1951 the staff of geographical faculties of universities included 61 doctors and 131 candidates, of which one half were either at Moscow or Leningrad universities. Assuming the same ratio of doctors and dotsents to other instructors as at Moscow University, the total number of instructors in geography at all universities must approximate 340. This gives the ratio of students to instructors as between 15 and 16, which is considered quite "inadequate". The suggested remedy is to separate instruction at universities into two categories, one for teachers and another for prospective workers in research institutes and production establishments. This latter training will be given only at the strongest universities - Moscow, Leningrad, Kazan' and Tashkent.

Table II lists degrees in gravimetry and geodesy which are conferred by faculties other than those of geography. The contribution of universities to the subject of gravimetry has been very large, especially before the war. The universities of Leningrad, Moscow, Kazan' and Tashkent (Sredneaziatskiy) are especially important in this respect. In 1949 the chairman of gravimetry at Moscow University was Professor L.V. Sorokin, one of the outstanding gravimetrists in the U.S.S.R., especially known for his undersea measures of gravity.

Another connection of Moscow University with geodesy is through the Astronomicheskiy Institut im. Shternberga (Sternberg Astronomical Institute) where an amazingly detailed study of the methods of determination and of variation of astronomical time is being carried on.

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The problem of research versus teaching is as acute in Soviet universities as anywhere else. In large centers like Leningrad and Moscow a great deal of research is accomplished by the university staff. In provincial universities the situation is probably not as favorable for research. At least we have the complaint of a geographer [5] from Kazan' that much more time than the stipulated 50 percent must be devoted to teaching activities and less to research.

In order to give a rounded picture of Soviet training in geography mention must be made of the Pedagogicheskiy Instituty (Pedagogical Institutes). These institutes are primarily designed for the training of teachers for middle schools (Srednyaya shkola) but considerable research of local significance is carried on in some of them. This research results in such items as guide-books, detailed investigations in the geography of individual regions, compilations of bibliographies, etc.

Of the 137 pedagogical institutes, 65 had specialties of geography in 1952. Two of them in Moscow (Table II) can even accept aspirants for the degree of doctor of geographical sciences.

Teachers' institutes (Uchitel'skiye instituty) prepare teachers as elementary school instructors. Of these institutes, 162 offer specialties in geography (1952).

The total number of students majoring in geography in both types of institutes in 1951 was 22,500 [15].

Soviet authors attach extraordinary significance to the availability of so many persons with a geographical background. The two volumes of "Voprosy Geografii", No. 23 (1950) and No. 25 (1951), are largely devoted to a discussion of the role of teachers of geography in regional studies (krayevedeniye) and in inculcating students with the idea of man's mastery

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over nature. In the words of S.V. Kalesnik, a noted glaciologist at Leningrad University, "geography used to mean the study of landscape; with us geography is control over landscape."

B. OTHER INSTITUTIONS OF HIGHER EDUCATION

1. Khar'kovskiy Inzhenerno-Stroitel'nyy Institut (Khar'kov Institut of Civil Engineers), Khar'kov, Sumskaya No. 40.

Prior to World War II this Institute was very active in the training of geodesists. Its faculty of geodesy was described as being one of the three geodetic schools in the U.S.S.R. [20], along with the Moscow and Novosibirsk Institutes of Engineers of Geodesy. In 1940 the Khar'kov Institute of Civil Engineers graduated 89 geodesists. For the school year, 1940-1941, the following enrollment figures were set:

Moscow	400 students
Novosibirsk	150 students
Khar'kov	75 students

Perhaps prior to 1939 there existed an independent institute of geodesy in Khar'kov. For 1939 we have [21] a definite statement that the Khar'kov Institute of Civil Engineers had faculties of (a) architecture, (b) construction and (c) geodesy. The latter was subdivided into departments of geodesy and gravimetry, and of photo-geodesy (apparently photogrammetry). In the official reference books of 1950 and 1952 the geodetic faculty is not mentioned, whereas faculties (a) and (b) with two other faculties are described [3].

As to the reasons for this change, nothing definite can be asserted. Obviously it was connected with the re-organization of training in the Ukraine after the disruption produced by the war. As a similar change occurred in the

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school described in Section 2, perhaps we may infer that the Soviets consider the two professional schools of geodesy in Moscow and Novosibirsk adequate for their needs.

2. L'vovskiy Politekhnicheskiy Institut (L'vov Politechnical Institute) L'vov, Ulitsa Stalina, No. 12.

The reference book [3] of 1950 lists a separate geodetic faculty with specializations in astronomy-geodesy and in surface field geodetic work. The 1952 edition of this book does not mention this faculty. Instead of it we find specialties astronomy-geodesy and engineering geodesy in the Geologic Prospecting Faculty. It would seem that general training in geodesy is no longer given in this school.

3. Moskovskiy Institut Inzhenerov Zemleustroystva (Moscow Institute of Land Surveyors), Moscow, Ulitsa Kazakova No. 15.

This institute has two faculties, one of land surveying and the other of geodesy. The description of its training in geodesy reads, "the engineers should be able to conduct land and aerial photographic surveys of large farming territories and prepare special maps". The training in geodesy appears to be restricted to practical application of surveying.

4. Leningradskoye Vysshaya Arkticheskoye Uchilishche (Leningrad Higher Arctic School), Leningrad, M. Okhta, Zanevskiy, No. 5.

Nothing is known about this school beyond the fact that it is in the system of the Glavsevmorput' and offers candidate degrees in hydrography, astronomy and geodesy. The training of geodesy is obviously connected with Arctic surveys. The contents of the publications of this school ("Uchenyye Zapiski", Vol. 1, 1949) reveal the existence of the chairs of astronomy and geodesy.

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5. Timiryazevskaya Sel'skokozyaystvennaya Akademiya (Timiryazev Agricultural Academy), Moscow, Novoye Shosse, No. 51.

Very little is known about the geodesy curriculum of this Academy except that in 1946 a Kafedra Geodezii was included in a description of the Academy's activities [22]. In a later reference [23] the subject of geodesy is not mentioned. Presumably, geodetic work had been restricted to land use surveys of some sort but nothing is definitely known at this time.

6. L'vovskiy Sel'skokhozyaystvenyy Institut (L'vov Agricultural Institute), L'vov, ploshchad' Bogdana Khmel'nitskogo, No. 1.

A source [24] of 1948 lists this institute as offering a "Speciality" in geodesy. A later reference [23] does not include the subject in its curriculum. Geodetic work of the institute probably was much the same as that of (5) above.

7. Voronezhskiy Sel'skokhozyaystvennyy Institut (Voronezh Agricultural Institute), Voronezh, Ul. Lomonosova, 29.

Information on the geodetic activities of this Institute is exactly the same as for (6) above.

8. Omskiy Sel'skokhozyaystvennyy Institut (Omsk Agricultural Institute Omsk, Staraya Zagorodnaya Roshcha.

A reference [3] of 1950 states that this Institute still offered a specialty in geodesy at that time.

9. Voyenno-Inzhenernaya Akademiya imeni V.V. Kuybysheva. (Military Engineering Academy) in Moscow.

This institution trains engineers for the army. It is known that it has a department of geodesy and cartography, but very little about its de-

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tailed activities has been found. Several books, however, published by this academy have been found and they indicate considerable research in geodesy, cartography and photogrammetry.

This and the following academy is listed among those institutions authorized to train students for advanced degrees.

10. Voyenno-Vozdushnaya Akademiya imeni N. E. Zhukovskogo (Military Air Academy) in Moscow (not to be confused with a similar academy in Leningrad).

This academy publishes a "Trudy" of which No. 102 appeared in 1944. None of this serial is available. The notice describing its contents, however, indicates considerable interest in the problems of geodesy and photogrammetry.

11. Voyenno-Topograficheskaya Shkola (Military Topographers School) in Leningrad.

This training school for topographers has a status lower than that of the Military Engineering Academy.

Total enrollment in these three military schools in geodesy and cartography must be rather large, of the order of about 500 people. Annual graduation of engineers specializing in geodesy should thus be in the neighborhood of 100.

A total number of engineers in geodesy, cartography and photogrammetry in the U.S.S.R. is undoubtedly large, approximating 10,000. This would exclude civil engineers carrying out cadastral work, ordinary surveyors, technicians, etc.

If we restrict our attention to the post-revolutionary period we can offer the following estimates:

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Graduates of the MIIGAiK	6,000
Graduates of the NIIGAiK	1,000
Khar'kov Inzh.Stroit.Inst.	500
Other civilian schools	500
Military schools	2,000
Total	10,000 graduates

C. SPECIAL SCHOOLS OF HIGHER EDUCATION IN GEODESY AND CARTOGRAPHY

At the present time there are two institutes for engineers of geodesy, aerial surveying and cartography, one is Moscow and the other in Novosibirsk, which are designed primarily for the training of scientific personnel in the fields of geodesy and cartography. Until 1946, both institutes were directly under the GUGK but are now listed in the system of the Ministry of Culture. In organization they are very similar but the Moscow Institute is much larger and of a higher standing than the Novosibirsk Institute.

1. Moskovskiy Institut Inzhenerov Geodezii, Aerofotos"yemki i Kartografii (MIIGAiK)

   Moscow, Gorokhovskiy Pereulok, No. 4.

This institute has a long history. It was founded in 1799 as Konstantinovskiy Mezhevoy Institut (Constantine Institute of Surveying) which name it retained until 1917. Between 1917 and 1930 it was known as the Moskovskiy Mezhevoy Institut. In 1930 the part of the Institute dealing with Cadastral Surveying became the Institut Inzhenerov Zemleustroystva (Institute of Land Surveyors, described in Section B) and the Faculty of Geodesy of the Mezhevoy Institute was reorganized into a new institute called the Moskovskiy Geodezicheskiy Institut, with five departments: astronomic-geodetic, photo-geodetic, cartographic-geodetic, geodetic instrumentation and municipal planning. In 1936 the institute

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was given its present name and largely its present structure.

The history of this institute is, of course, very involved and need not be dealt with here. It is enough to say that the emphasis between 1799 and 1917 was almost exclusively on practical surveying. There was very little research work in, or even teaching of, higher geodesy. Nevertheless, as is true of almost any institution of higher education in Russia, after 1905 rapid development toward the improvement of both the quality and quantity of teaching and research took place in the institute.

Despite this inadequacy in teaching facilities the institute, before the revolution produced such first class geodesists and cartographers as F.N. Krasovskiy, A.S. Chebotarev, M.D. Solov'yev, V.V. Danilov, and many others who were able later to organize and direct teaching and research in geodesy on a much larger scale. This situation is typical of Soviet reality. The few scientists and engineers of the old school who remained loyal to the government were given the means and opportunity to organize teaching and research in their specialty and were able to produce an entirely new generation of scientists and engineers.

a. PROGRAM OF INSTRUCTION

Programs of instruction, revised several times, were finally consolidated in 1938. These programs, with but few changes, are still in force. These changes were due largely to the introduction of additional subjects to be taught which in turn necessitated an increase (in 1949) of the length of the period of instruction from 4 years, 8 months to 5 years, 6 months [24].

The list [25] of 62 subjects taught in 1939, is organized under four faculties, of which the cartographic faculty has three departments. They are as follows:

[redacted]

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1. Geodetic faculty

2. Aerophotogeodetic faculty

3a. Cartographic faculty, cartographic-geodetic department.

3b. Cartographic faculty, map compilation department.

3c. Cartographic faculty, polygraphic department.

4. Optical-mechanical faculty.

In the following table this information is condensed into 18 areas of instruction and the number of hours of instruction is given in each faculty or department according to the above scheme.

TABLE III

PROGRAM OF INSTRUCTION

Subjects	Departments					
	1	2	3a	3b	3c	4
Political Science	380	380	380	380	380	380
Foreign Languages	250	250	250	250	250	250
Physical and Military Training	290	290	290	290	290	290
Mathematics	741	612	417	417	527	702
Physics	196	290	164	164	173	288
Chemistry and Photography	88	242	152	152	563	126
Drawing	136	122	253	344	536	164
Geodesy and Astronomy	1022	677	755	524	-	207
Geography and Geology	158	85	664	664	-	-
Cartography	148	150	505	837	367	-
Applied Optics	-	68	-	-	-	438

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TABLE III (cont'd)

	1	2	3a	3b	3c	4	
Radio	68	-	-	-	-	-	
Geophysics and Gravimetry	256	-	-	-	-	-	
Photogrammetry and Aerial Surveying	285	962	200	81	-	132	
Statistics and Economics	-	-	-	119	-	-	
Map Technology	-	-	-	-	1060	-	
Technology of Metals	-	-	-	-	222	1529	
Organization of Production	179	102	138	95	140	100	
Total	4197	4230	4168	4317	4508	4606	hours

This program of instruction was somewhat modified in 1943, but the number of the faculties remained four. The change amounted only in taking the department of cartographic geodesy from the Cartographic Faculty and putting it into the Geodetic Faculty as one of the two specialties, the other specialty being Astronomic Geodesy. The Optical Mechanical Faculty was renamed the Geodetic Instrumentation Faculty.

In 1950 a reorganization [23] more or less reverted to the 1938 scheme. The four faculties were the same as in 1943, but the Geodetic Faculty had two specialties, the Astronomic Geodesy and Surface Geodesy; the Cartographic Faculty also had two specialties, Map Compilation and Map Production (corresponding to the Polygraphic Department of 1938).

The scheme of instruction of 1938 is the latest detailed scheme available at the present time. The plan of 1943 introduced, not a change of emphasis, but an overall increase of instruction hours in key subjects according to specialties. The percentage increase of the hours is described by Zubakov

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and Zakatov [26] as follows:

Geodetic Faculty: Astronomic-Geodetic Specialty

Gravimetry: increased 37 percent

Geophysics: increased 100 percent

Cartographic Geodesy Specialty

Geodesy: increased 28 percent

Higher Geodesy: increased 14 percent

Field Astronomy: increased 66 percent

Compilation of maps: increased 23 percent

New subjects introduced: Field cartographic-geodetic work

Application of geodesy to engineering

Aerophotogeodetic Faculty

Mechanics and Instrumentation: increased 62 percent

Aerial Photography: increased 58 percent

Physics and Applied Optics: increased 15 percent

New subject introduced: Applications of Aerial Surveying

Cartographic Faculty

Geodesy: increased 50 percent

Geography: increased 12 percent

Map Editing: increased 50 percent

Geodetic Instrumentation Faculty

Geodesy and Practical Astronomy: increased 70 percent

New subject introduced: Geodetic Instrumentation 186 hours.

Aspirants for the degree of "doctor" or "candidate" of technical sciences may work in the following specialties [8]:

[redacted]

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1. Astronomy
2. Geodesy
3. Higher Geodesy
4. Gravimetry
5. Field Cartography
6. Mathematical Cartography
7. Compilation and Editing of Maps
8. Map Production
9. Map Design
10. Photogrammetry
11. Aerial Surveying
12. Instrumentation
13. Applied Optics
14. Specialized Technology
15. Physical Geography

Each of the above-named specialties requires the existence of a chair, involving one professor (chairman) and several other professors, dotsents, assistants and teachers. In fact, in 1939 ten of the chairs in the list (No. 1-3; 6-7; 10; 12-14) are mentioned in addition to the chair of mathematics in which no aspirants were allowed, and a general statement is made of the existence of 24 chairs [25].

In 1949 two new chairs were established [24], one in applied geodesy and economics and another in the organization of geodetic and cartographic production. The number of chairs at the present time may well be 30.

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b. DEFINITION OF AIMS

The latest statement concerning training aims [23] reads somewhat differently from that appearing in the same handbook of 1947. Apparently no stabilization in the definition of aims of geodetic and cartographic training has yet been achieved and further changes are possible. In 1950 we have the following specifications:

Geodetic Faculty, Astronomic-Geodetic Specialty. The training of engineers is based on the fundamental study of the problems of higher geodesy, theory of the figure of the earth, geophysics, gravimetry and practical astronomy.

Geodetic Faculty, Surface Geodetic Work. The training of engineers is based on a study of physics, mathematics, geography and engineering.

Engineers of this specialty should be able to conduct investigations for large engineering projects, such as railroads and highways, canals, hydroelectric stations, irrigation and drainage systems, etc.

Aerophotogeodetic Faculty. In the training of engineers in this group, much emphasis is placed on physics, applied optics, mechanics, geodetic instrumentation, geodesy and photogrammetry.

Aerophotogeodetic engineers are expected to conduct both field and laboratory geodetic and photogrammetric work for the purpose of preparing large scale maps.

Cartographic Faculty - Compilation of Maps Specialty. In the training of engineers in this specialty much attention is paid to cartography, as well as to geodesy and geography. The engineer must be able to deal with already available material which should be selected, analysed and used for the compilation of maps. He should also have a sound foundation in chemistry, physics

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and polygraphy. Such engineers usually find employment in the map compilation departments of cartographic factories.

Cartographic Faculty, Production of Maps Specialty. In this group, the emphasis in training is on cartography as well as on colloidal chemistry and polygraphy.

Geodetic Instrumentation Faculty. Here, training is based on the general engineering course, obligatory for all engineering schools, as well as on courses specifically dealing with geodetic instruments.

The engineers are expected to be highly qualified experts in the construction of geodetic instruments and other optical and mechanical apparatus used in cartographic and geodetic production. Such engineers are generally employed in factories making precision instruments.

c. ENROLLMENT

Detailed figures for the enrollment in this institute for the period 1919-1939 are [25].

1919	66 students	1926	67 students	1933	125 students
1920	70 students	1927	50 students	1934	175 students
1921	185 students	1928	53 students	1935	190 students
1922	246 students	1929	80 students	1936	125 students
1923	256 students	1930	220 students	1937	260 students
1924	105 students	1931	250 students	1938	310 students
1925	no data	1932	175 students	1939	420 students

The above figures total (assuming an average enrollment for 1925 and including 100 students in night classes) about 3,500 students admitted. It is stated that in the period between 1919-1939, 2,500 engineers were graduated from the institute, a figure representing about 70 percent of those entering. This may be considered a good record.

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Annual enrollment for the years of 1940-41 was planned to include 400 students, and this figure probably remains about the same at the present time. Adopting this figure as the number of entrants, and 70 percent of these as graduated, the annual graduation would amount to about 280 engineers, or 3,640 for the period 1940-1952. With the definite figure of 2,500 for the period of 1919-1939, it is evident that the Moscow Institute alone has contributed to Soviet geodesy and cartography no fewer than 6,000 highly qualified engineers.

These figures, imposing as they are, constitute only part of the picture. The system of correspondence training (zaochnoye obrazovaniye) and night schools is very well developed in the U.S.S.R. Correspondence training was especially prevalent before the war when the lack of experts was keenly felt, but even now there are some institutes of higher education which give only correspondence training. The idea behind these schools is, of course, to provide technical education for those who for some reason cannot become full-time students. Paralleling this training for advanced degrees, special courses were established for fully qualified engineers wishing to become acquainted with newer methods and developments in their specialty.

The Moscow Institute of Engineers of Geodesy, along with other institutes, established such courses in 1938. The response was immediate and overwhelming. In less than two months over 700 applications were received, and the enrollment had to be closed. These correspondence courses existed for some time and then were discontinued and have not been mentioned since the war. Apparently the lack of engineers was relieved by the establishment of another institute in Novosibirsk in 1940.

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The number of higher degrees conferred by the MIIGAiK must be rather large and probably exceeds 100. The only definite evidence in this respect is for the year 1950. In that year five doctor and 14 candidate dissertations were submitted*. Among the doctoral dissertations we see that of A.I. Mazmishvili who in 1940 was director of the institute. His dissertation was on the adjustment of geodetic measurement.

Among the 14 candidates four had dissertations on the application of gravity to geodetic problems, an evidence of great attention paid to such problems in the U.S.S.R.

* Dissertations Presented for Degrees in Science and Engineering in Moscow in 1950, Foreign Documents Division, CIA, Summary No. 71. Secret.

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d. FACILITIES

The MIIGAiK appears to be very well equipped. It has a special library of over 240,000 books, an astronomical observatory, applied optics and printing shops and 28 laboratories and exhibit rooms. It is emphasized that all available publications in foreign languages are systematically acquired by the library, and there is a special staff of consultants on duty in the library to assist students in the English, German, French, Italian and Spanish languages.

The institute has its own serial publication "Trudy" of which none has reached this country. In 1950, Vols, 3-8 were issued, comprising altogether about 500 pages.

e. STAFF

The difficulty in establishing the exact identity of each member of the staff of the MIIGAiK is that it overlaps very largely the staff of the TsNIIGAiK, (Central Research Institute of Geodesy, etc.), even now despite the decree of 1944 prohibiting such overlapping. During the period of 1939-1950, 66 persons were definitely connected with the MIIGAiK in either a teaching or research capacity. How many of these people are still at the institute and how many new people have been added since, is impossible to establish. The reason for this is very simple and applied equally to all sciences. Soviet authors, by design or by habit, very rarely indicate their academic or institutional connections when they publish a paper. This information may or may not be contained in the text of the paper, and in many cases the precise connection of individuals is unknown.

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During this same period the staff of the TsNIIGAiK consisted of 155 people, 18 of whom also appear on the staff list of the MIIGAiK.

The latest available reference [23] is not helpful in this respect, stating simply that the teaching staff is large and includes five distinguished workers of science and industry, and 17 doctors of science. This would total 22 people, probably mostly chairmen. The entire teaching staff is certainly not less than 60 or 70 persons.

In 1940 the director of the MIIGAiK was A.I. Mazmishvili, not a distinguished figure in Russian geodesy. It is not known whether he is still director. The strongest figures in research on the staff are invariably also connected with the TsNIIGAiK and will be discussed in that connection.

2. Novosibirsk Institut Inzhenerov Geodezii, Aerofotos"yemki i Kartografii (NIIGAiK), Novosibirsk, Ulitsa Potanina No. 27.

As has been stated before, this is a much smaller institute than the MIIGAiK. It is listed as conferring higher degrees in the following specialties:

Higher Geodesy

Astronomy

Photogrammetry

The Institute publishes its own "Trudy" of which Vol. 1 (1947) and Vol. 2 (1948) are known to be in existence. The editor of these "Trudy" is Professor V.V. Popov, probably director of the NIIGAiK.

In all probability the NIIGAiK grew out of the Geodetic Faculty of the Novosibirsk Institute of Civil Engineers (Novosibirskiy Inzhenerno-Stroitel'nyy Institut). This Geodetic Faculty was added to the institute in 1932 and by 1937 had an enrollment of 175 students. The Geodetic Faculty was to replace an independent Astronomic-Geodetic institute in Omsk

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which was abolished at about that time.

D. ENTRANCE REQUIREMENTS TO INSTITUTIONS OF HIGHER EDUCATION

No report on the educational aspects of Russian training would be complete without some reference to requirements for admission to schools of higher geodetic and cartographic education. A book published in 1950 by the Ministry of Higher Education 3, gives a comprehensive list of such requirements. Appendix B of this report is a detailed translated abstract of these rules. For the purpose of this paper, however, only those features of most significance to geodetic and cartographic training are included in the body of the report, as follows:

I. Accepted in VUZY* - Citizens of U.S.S.R. of both sexes from 17 to 35.

- in Correspondence and Evening VUZY (divisions) - without definite age limit, provided they have completed an intermediate education and successfully passed the examinations set up for those entering these educational institutions.

Note: - (a) Persons who have graduated from tekhnikums or other intermediate specialized educational institutions comparable to them, will be accepted in VUZY provided they have completed the 3 years' production experience established by law after completion of the intermediate educational institution. Such experience is not required of those enrolling in correspondence and evening VUZY and divisions nor from those included in the upper 5% of those graduated from each tekhnikum as well as from those people who, at the close of a tekhnikum, are participating in the three or more years program of active military service.

* VUZ(Y) is the standard abbreviation of Vyssheye Uchebnyye Zavedeniya (Institutions of Higher Education) used in Soviet literature.

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(b) In accordance with decree No. 426 of the Sovet of Ministers of the Union of SSR of Feb. 1, 1949, it has been decided to accept temporarily for a period of 5 years, for the first course of teachers' institutes without preliminary experience by the enrollees those who have completed pedagogical training schools under the direction of the Ministries of Education of the Union Republics.

II. Those people who, at the close of intermediate schools, have been awarded gold or silver medals, "for outstanding successes and exemplary conduct", will be accepted in institutions of higher education without entrance examinations, provided that, first of all, there shall be admitted those awarded the gold medal and next those awarded the silver medal.

Also without entrance examinations will be accepted those persons who have completed tekhnikums with a rank of "excellent", who are included within the upper 5% of those graduated from a tekhnikum or a three-year intermediate medical school and who enroll in institutions of higher learning according to their specialty within 2 years, including the year of completion.

III. Those enrolling in higher educational institutions, with the exception of those mentioned in paragraph 2, shall take entrance examinations depending upon the specialty of the higher educational institution:

1. in VUZY and faculties of machine-construction, metal-work, metallurgy, mechanics, electrical mechanics, electrical technology, energetics, communications, mining, geology, oil, aviation, geodesy, hydrometeorology, hydrography, auto-transport, railroad, water transport, forestry, chemical technology, cinema-engineering - in the following subjects:

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a. mathematics, b. physics, c. chemistry, d. Russian language and literature, e. one foreign language (English, French or German);

2. in VUZY and faculties of history, jurisprudence, geography, library science, and also in pedagogical faculties of pedagogical institutes - in the following subjects:

a. history of peoples of the U.S.S.R, b. geography, c. Russian language literature;

3. those enrolling in teachers' institutes shall take entrance examinations in the following subjects:

a. in the natural science - geographic division - a. in Russian language and literature, b. geography, c. chemistry;

b. in the physics-mathematics division - a. in Russian language and literature, b. mathematics, c. physics.

IV. Entrance examinations shall be given in accordance with the programs approved by the Ministry of Higher Education of the U.S.S.R.

V. Persons who have received an unsatisfactory grade on the written examination in the Russian language or the language, in which the instruction in the given VUZ is carried on, shall not be admitted to further examinations.

E. TEXTBOOKS OF GEODESY
(Exclusive of Gravimetric Textbooks)

A large collection of Russian textbooks of geodesy has been made at this Laboratory. An itemized list is given in Appendix C of this report. A study of these and a comparison with American, British, German and Swiss texts, reveals some rather significant and illuminating facts.

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Soviet geodesists have published at least,

1. five textbooks of higher geodesy, four of them between 1948 and 1951 and written by such outstanding geodesists as Rabinovich, Chebotarev and Krasovskiy;

2. a tremendous nine-volume set of reference books dealing with the higher aspects of geodesy, photogrammetry and cartography (1941-1949);

3. four textbooks of "Lower Geodesy";

4. ten "special type" textbooks, dealing with such subjects as naval geodesy, agricultural geodesy, engineering (several types) geodesy, architectural and aerial geodesy, geodesy for auto road construction, and geological geodesy (1948-1950);

5. a book outlining the "norms" for each phase of geodetic work (1949); and

6. numerous field instructions, manuals for triangulation, gravimetry and photogrammetry.

7. In addition to the above, the Laboratory has located six geodetic textbooks of both "higher" and "lower" geodesy published since 1947 by such "iron-curtain" countries as Bulgaria and Czechoslovakia.

This is an impressive array of the scope of Soviet educational activity in this field and appears even more impressive when it is remembered that the two most famous, but outdated, English language geodetic textbooks (by Hosmer, 1930 and by Clarke, 1880) used by present day English speaking geodesists, have only in the last year been brought up-to-date by Brig. Bomford's new text. The only possible way to make direct comparison between Soviet and American geodetic texts of "higher geodesy" is to collect, analyze and combine the numerous monographs, books, and scientific papers published on various aspects of the geodetic sciences by the U.S. Coast and Geodetic

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Survey and other federal and military mapping agencies. The additional fact that until 1951 there was no U.S. university or institute teaching advanced courses in geodesy, of course explains, in part, the paucity of American textbooks (or even textbooks written in the English language) and makes the task of comparing with Soviet work that much more difficult.

The problem of inter-comparing American and Soviet textbooks of the "lower geodesy" type is somewhat easier, if we assume that American textbooks on surveying (civil engineering, route surveys, railroad right-of-way surveying, etc.) are essentially comparable to Soviet textbooks of "lower geodesy".

A detailed discussion of a feature-by-feature comparison between American, British, German and other foreign texts of geodesy with Soviet textbooks is beyond the scope of this paper. However, several general impressions and comparisons may be briefly outlined as follows:

1. Soviet textbooks are written in great detail - to a far greater degree than those of any other nationality.

2. Descriptions of all types of geodetic instrumentation are exhaustively treated in Soviet texts. Such subjects are merely touched on in the American literature.

3. The type of material presented in Russian texts suggests that students of the subject in the Soviet Union are subjected to a much more rigid indoctrination in such allied sciences as mathematics, physics, and astronomy then is usual in the United States. In this respect, indeed, their education at least equals and, in some respects, even exceeds that of German training.

4. Soviet textbooks in all sciences offer valuable clues to trends in both Soviet science and Soviet education. They also occasionally give

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concrete data not published in other media available in this country.

F. INTERMEDIATE EDUCATION IN GEODESY AND CARTOGRAPHY

The necessity of having personnel intermediate between a skilled worker and an engineer has always been felt keenly in Russia. Gradually schools something like junior colleges of specialized training have been developed. It is worthy of notice that the Soviets do not consider these as institutions of higher learning. Their organizations, programs, length of instruction, however, leave no doubt that they are on a much higher level than U.S. trade-schools. Students graduating from these schools receive a diploma as a technician (tekhnik). In 1948 there were ten such schools generally known as "topograficheskiy tekhnikum" under the direct supervision of the GUGK (Main Administration of Geodesy and Cartography).

1. Kiyevskiy Topograficheskiy Tekhnikum

   Kiyev, Glubochinskiy Per. No. 6

2. Leningradskiy

   Leningrad, Ul. Saltykova-Shchedrina, No. 45-a

   Specialties: topography, cartography

3. Moskovskiy

   Moscow, Klimentovskiy Per., No. 1

   Specialties: topography, cartography

4. Novosibirskiy

   Novosibirsk, Ul. Krylova, No. 24

   Specialty: topography

5. Semipalatinskiy

   Semipalatinsk, Ul. Uritskogo, No. 19

   Specialty: topography

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6. Tashkentskiy

   Tashkent, Shakhrizabskaya ul., No. 1/3

   Specialties: topography, cartography.

7. Tbilisskiy

   Tbilisi, Ul. Marra, No. 27

   Specialties: topography, cartography, road construction.

8. Tomskiy

   Tomsk, Ul. Rosy Luksemburg, No. 13

   Specialty: topography

9. Chkalovskiy

   Chkalov, Ul. 9-go Yanvarya, No. 23

   Specialties: topography, cartography

10. Moskovskoye Aerofotos"yemochnoye Uchilishche

    Moscow, Gorokhovyy Per. No. 4

    Specialties: photography, photogrammetry, photo-topography.

The history of these tekhnikums is very involved [25]. In 1920 only two such schools existed, one in Leningrad and another in Moscow with an enrollment of 100-120 in each. At the end of 1930 the following tekhnikums were in operation:

Moscow	Tbilisi	Semipalatinsk
Leningrad	Saratov	Omsk
Khar'kov	Sverdlovsk	Khabarovsk
Novocherkassk	Tashkent	Mogilev (since 1932)

This network was designed to take care of geodetic and cartographic needs but was, nevertheless, soon almost wholly destroyed (1932-33). The purely geodetic and topographic tekhnikums were absorbed into a larger

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system of geological and hydrological prospecting tekhnikums. Geodetic service was merged with hydro-geologic service (1933-44). All this is ascribed in Soviet literature to "sabotage of the enemies of the people".

Later in 1935 geodesy and cartography were again separated from hydrology and geology, merged into an independent service and incorporated in the system of NKVD. By that time the only four geologic-hydrologic tekhnikums remaining in operation were re-organized into independent topographic tekhnikums:

Leningrad	Tomsk
Tbilisi	Tashkent

In 1939 these four tekhnikums gave instruction in the three following specialties: topography: graduates (tekhnik-topograph) were expected to be able to conduct theodolite surveys, to establish simple geodetic control for aerial photography, to analyze relief from photos of all scales and to carry out leveling of IV-order. geodesy: graduates (tekhnik-geodezist) should be able to execute field observations and computation of coordinates of II-order supplementary triangulation networks, to handle traverse work of II and lower order and to establish all the necessary control for aerial photography. cartography: graduates (tekhnik-kartograf) should be able to compile maps from available material and to substitute as technical editors of maps.

The length of instruction for these specialties was three years, ten months (or 11 months, depending on the specialty). Enrollment was open to persons with seven years of elementary and middle school (that is, generally 15-16 years of age, corresponding to the American junior high school level). All students in topographic schools took the following general subjects:

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History of the U.S.S.R.	180 hours
Leninism	60 hours
Political science	100 hours
Total	340 hours

Instruction in basic subjects was organized as follows:

	Topographic	Geodetic	Cartographic
Mathematics	440 hours	440 hours	384 hours
Physics	246 hours	246 hours	227 hours
Chemistry	85 hours	85 hours	146 hours
Russian	324 hours	324 hours	328 hours
German	208 hours	208 hours	208 hours
Economic Geography	60 hours	60 hours	60 hours
Total	1,363 hours	1,363 hours	1,353 hours

Instruction in professional subjects:

	Topographic	Geodetic	Cartographic
Geodesy	516 hours	556 hours	270 hours
Photography and phototopography	270 hours	150 hours	85 hours
Geography, geology, geomorphology	303 hours	330 hours	404 hours
Topographic and cartographic drafting	409 hours	409 hours	474 hours
Cartography	100 hours	-	302 hours
Organization of Production	40 hours	40 hours	54 hours
Practical Astronomy	-	80 hours	-
Technology of Map Production	-	-	227 hours
Total	1,638 hours	1,565 hours	1,816 hours

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In addition to all this, students were supposed to take field work and training in production practice, as follows:

FIELD WORK

	Topographic	Geodetic	Cartographic
1st year	10 weeks	10 weeks	10 weeks
2nd year	11 weeks	11 weeks	6 weeks
3rd year	11 weeks	11 weeks	-

PRODUCTION PRACTICE

3rd year	13 weeks	13 weeks	15 weeks
Total	45 weeks	45 weeks	31 weeks

There is no detailed breakdown of this instruction according to years. If we consider the reasonable scheme:

Academic work	36 weeks
Field work	10 weeks
Vacation	6 weeks
	52 weeks

we find that the student must take from 3,341 to 3,529 hours of academic work in three and one-half years or 126 weeks. This would mean a load of 26 to 28 hours per week. If this figure is accurate, the intensity of training in academic subjects at these levels is very much higher than in any American Liberal Arts college where the normal load for students is supposed to be 18 hours per week.

Such thorough and long training programs conflicted with the urgent demand for technicians and in 1938 an attempt was made to condense the course of instruction in geodetic technicians into two years. This was

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found to be possible only if matriculating students had the full ten-year high school credentials (that is, 18 years of age). In 1939 two groups of topographers at the Leningrad tekhnikum were being trained to test this plan.

Apparently this attempt was abandoned [28] for in 1947 it is definitely stated that the acceptance of students to all tekhnikums is based on the 7-year high school certificate.

Since, in 1937-40, the supply of technicians was inadequate to supply the rapidly developing economy, at least two short-cuts were attempted in the training of geodetic technicians, both of which were abandoned by 1939 as not meeting the requirements.

First, some promising young people were assigned as apprentices to learn one particular branch of geodesy or cartography in a period of 6 to 7 months. This attempt resulted in one-sidedness and confusion of students.

Secondly, at the end of 1937, in order to supplement the number of technicians produced by the schools in Leningrad, Tbilisii, Tomsk and Tashkent, special training centers were established at Aerogeodetic Establishments (Predpriyatiya) with three years of training to be added to the nine or ten years of the middle school (Srednyaya Shkola). Graduates of these centers could take special examinations and qualify for the certificate of a technician. The advantage of this system was the participation of the student in actual production. It was found, however, that this idea did not work because of a dearth of qualified teachers, equipment, textbooks, etc. In 1939 all of these training centers were either abolished or developed into independent geodetic tekhnikums.

In perusing the literature one is struck with the Soviet desire to change the situation overnight. The late thirties and early forties were

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times when not only complicated geodetic instruments were hard to get, but ordinary paper and pencils were scarce. Yet under the whip of the five-year plans geodetic education had to be provided no matter what the cost, and the cost was human life. Obviously mistakes were unavoidable because of lack of knowledge, experience and general chaos. Yet the immediate reactions to all of these failures was to "hunt for the culprits who deliberately sabotaged geodetic training". Such culprits are named on every page, as "enemies of the people", ..."in the pay of capitalistic countries", ..."the ones who suggested the merger of geological, hydrological and geodetic service into one unit", etc. What happened to these unfortunate individuals is impossible to ascertain. It is safe, however, to assume that Soviet geodesy, as well as other sciences and industries, lost many talented and devoted people.

In 1944 seven topographic tekhnikums (not named) and the Moscow School of Aerial Photography (organized in 1939) are mentioned [26]. In the seven tekhnikums the total enrollment was 1,267 students and in the Moscow School of Aerial Photography the enrollment was 306 students.

The description of training agrees with that of 1939, except that gravimetry is mentioned. Emphasis is on practice, theory being taught only to the extent that practice might be better understood. The amount of training was:

Theoretical Work	1,156 hours
Practical and Laboratory	1,196 hours
Total	2,352 hours
Field Work	43 weeks,

closely agreeing with the schedule given for 1939. Evidently this training was administered in a 3 years, 10 months period since a fourth year term is

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specifically mentioned.

For 1947 we have the following information [28] concerning the two Moscow tekhnikums:

In the Moscow Topographic Tekhnicums the length of instruction was 3 years 7 months, except for students who had completed the full "middle" school curriculum. Apparently both persons with the 7-year credentials and 10-year credentials of middle school were admitted, but the latter were credited with general subjects as described above. There were only two specialties, one in topography and the other in cartography.

In the Moscow Aerialphotosurvey School the length of training is said to be 2 years, 8 months but no further details were available. Apparently this means a requirement of a 10-year middle school certificate for admission.

In the 1947 list of tekhnikums a very interesting development is apparent. The specialty mentioned most often is either that of topography or cartography. What has become of the geodetic specialty? Apparently it was abolished between 1944 and 1947 and geodetic technicians were trained in some other way. This gap in our information is important and every possible effort should be made to fill in this loose end.

The same source gives general rules of admission. The limiting ages for both sexes for admittance to tekhnikums are 14 to 30 years for full time students. For part time students (that is for students already working in production) there is no age limit. There are entrance examinations in the Russian language and literature, mathematics, in the constitution of the U.S.S.R. and special examinations depending on the character of the tekhnikum, such as drawing for architects, etc. Prerequisite education must be the certificate of 7 years of middle school, but apparently students with educa-

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tion obtained in the 10-year period of the middle school are also admitted with corresponding credit in general subjects.

Students must pay tuition with the exception of veterans, children of veterans, etc. The amount of tuition is unknown. However, all students in tekhnikums are given scholarships of one of two categories. According to a description of this system, topographic tekhnikums should be in category (a) (Higher paying) with scholarships amounting to

1 year - - - 125 rubles per month

2nd year - - 150 rubles

3rd year - - 175 rubles

4th year - - 200 rubles

These scholarships are cancelled if the student's grade is less than 3 (corresponding to "C" in the American system) in any subject. For students having a perfect record of grade 5 (corresponding to "A"), all scholarships are automatically increased by 25%.

It is stated that the ruling of February 10, 1943 dealing with the improvement of instruction of students is also applicable to tekhnikums. What this ruling is, is not known at the present time.

Practically all tekhnikums have dormitories, dining rooms, etc. The only limitation for women so far discovered is that they are not accepted in the aerial photography department of the Moscow Aerophotographic School.

The system of incentives is strongly developed in tekhnikums just as it is in all Soviet schools. Apparently the "appeal of work for the reconstruction of the beloved fatherland", etc., is not enough and definite financial encouragement is provided.

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There is no evidence here, or anywhere in the Soviet system of education, of assignment to any particular institution. The student is apparently free to enter any school he chooses where he can meet basic requirements. But what prevents the student after completion of the course in a topographic tekhnikum from leaving that profession? Apparently nothing except the requirement that the student must serve for three years in the profession he chooses and in which he graduates. After that, if he has a certificate of the 10 year middle school, he can enter any university or technical college just as any other student might do.

That such a procedure is possible we have evidence of in a letter of a recent "D.P.", A.L. Belkin, now working at this Laboratory. After graduating from a Krasnodar high school he entered the Krasnodar Topographic Tekhnikum (not mentioned in any of the above quoted sources) from which he graduated in 1925. After participating in topographic work he entered Leningrad University in 1931 and graduated from there in 1935 with a degree "learned geographer-cartographer".

It would seem then, that a number of the better graduates from topographic tekhnikums go on to improve their education elsewhere and are thus lost to the system as technicians. It is impossible at the present time to establish the number of such departures but a figure of 10% of graduates seems to be a reasonable one. This might be considered as a leak in the Soviet geodetic education system.

We have then, as of 1948, a total of

9 tekhnikums with enrollment of	1,629 students
Moscow Aerial Photography School	306 students
Total	1,935 students

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About one-fourth of these would presumably graduate each year, making the total production of geodetic-topographic-cartographic technicians approximately 500 per year. This system has been in operation since 1937 and has, in those 16 years, produced something like 8,000 technicians. Between 1920 and 1937, also a period of 16 years, the number of schools was roughly one half of the present. We might expect, therefore, something like 4,000 technicians to have been produced during those years. All told, the number of graduated technicians should be in the neighborhood of 12,000. Considering the 10% leak, losses during the war, natural death, etc. we arrive at a final figure of 10,000 technicians in geodesy and cartography working at the present time in the U.S.S.R.

The tremendous scope of work being carried out at the Aerogeodetic Establishments, Cartographic Factories, etc. would require that many, and probably more, technicians. In fact, various devices have been used in the Establishments and Factories to raise the professional level of those workers already employed. This may be considered as evidence that technological personnel are still not considered adequate for the smooth running of the machine.

III. RESEARCH

As has been pointed out before, the boundary between research and teaching in the U.S.S.R. is deliberately obliterated. University professors are not only encouraged but, to some extent, are forced to participate in research, and many purely research institutes train students for advanced degrees. Research relating to geodesy and cartography is being carried out in many institutions in the U.S.S.R. This is especially true today since the introduction of electronic surveying methods which for

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the most part are being developed in research institutes of physics and astronomy. If our attention is restricted specifically to the problems of geodesy and map making, research institutes to be considered fall into four categories:

I. Central Research Institute of Geodesy, Aerial Surveying and Cartography.

II. Academies of Science

III. Main Administration of the North Sea Route

IV. Military Organizations.

A. TsNIIGAiK

Tsentral'nyy Nauchno-Issledovatel'skiy Institut Geodezii, Aeros"yemki i Kartografii (Central Scientific Research Institute of Geodesy, Aerial Survey and Cartography). TsNIIGAiK.

The Institute was founded in 1929 in Moscow under the name of the Institut Geodezii i Kartografii with a section of Aerial Surveying located in Leningrad. In 1931 the Leningrad section (Fontanka 33/35) became an independent Institute of Aerial Surveying (Nauchno-Issledovatel'skiy Institut Aeros"yemki). In the fall of 1934 both Institutes were again merged into TsNIIGAiK located in Leningrad. In 1936 (?) the main Institute was again transferred to Moscow, the Leningrad section remaining at the old address. Apparently the Leningrad section was closed during the war, although no direct reference to this fact has been found. The latest available reference to the Leningrad section appeared in 1940 [29].

The purpose of the Institute as outlined in 1935 [30] was as follows: the TsNIIGAiK was to investigate and improve methods of geodetic, cartographic and aerial surveying and to design new apparatus for the improve-

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ment of this work.

This statement is so general that it could be accepted as defining the work of the Institute even today. Later, work on gravimetry and the determination of precise time was included in the program of the Institute.

The first director and organizer of the Institute was F.N. Krasovskiy, the leading Soviet geodesist. In 1930 he resigned from this position and was replaced by I.A. Fishman, a man quite unknown in geodesy and apparently a figurehead. Krasovskiy remained at the Institute as deputy-director in charge of scientific work. From 1937 until the time of his death in 1948 he remained on the staff of the Institute as a consultant without administrative duties.

The scientific organization of the Institute, its program and the character of its work should be ascribed to Krasovskiy. This is emphasized in numerous obituaries published in connection with Krasovskiy's death [31].

The Institute immediately became a rather large organization. By 1935 the number of scientific workers [30] on the staff numbered 172 and the total number of people connected with the Institute, 330. The framework of the Institute included five divisions with numerous sections, as follows:

LIST NO. 1

I. Division of geodesy.
   1. Astronomic-gravimetric section.
   2. Geodetic Section.
   3. Geodetic Instrumentation Section.

II. Division of Cartography.
   1. Pedagogical and Special Maps Section.
   2. Topographic Map Section.
   3. Field Cartography Section.
   4. Stereophotogrammetry Laboratory.

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III. Division of Scientific Methods.

IV. Division of Aerial Photography.

1. Bureau of Design and Construction of Instruments.

2. Bureau of Design and Construction of Optical Apparatus.

3. Laboratory of Optics.

V. Division of Laboratories.

1. Laboratory of Photochemistry.

2. Laboratory of Photophysics.

3. Laboratory of Photometry.

4. Laboratory of Industrial Photography.

This organizational scheme was undoubtedly revised more than once, but on the whole it represents the activity of the Institute even at the present time.

In 1939 the following laboratories in Moscow are mentioned [32] some of which can be identified in the former scheme.

LIST NO. 2

a. Laboratory of Photogrammetry (probably development of the former Laboratory II-4).

b. Laboratory of Astronomy, Gravimetry and Geodesy.

c. Laboratory of Field Cartography and Map Compilation (II-3 ?)

d. Laboratory of Measurement of Long Distances by the Interference Method.

e. Laboratory of Spectrophotometry (former V-3).

f. Time Service.

g. Optical Mechanical Shop.

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The Leningrad Department (filial) had:

h. Laboratory of Optics.

i. Laboratory of Aerial Topography.

j. Laboratory of Aerial Photographic Apparatus.

The description of the framework of the Institute for 1939 is obviously incomplete since it does not include a very impressive amount of theoretical work underway at that time at the Institute. However, a more up-to-date scheme of organization has not yet been found. In 1943 the work of the entire Institute is described [29] without reference to subdivisions.

At the present time the Institute is included in the system of the Glavnoye Upravleniye Geodezii i Kartografii (GUGK) which is subject to the direct control of the Council of Ministers; that is, not forming a part of any particular Ministry. Control of the Institute by the GUGK is executed through the Collegium (Kollegium) of the GUGK, the main directing body of that organization. This control is very close as may be inferred from the following examples:

In June, 1948 the Collegium of the GUGK examined the results of the work of the TsNIIGAiK carried out the previous year. A number of the research workers at the Institute were praised for the excellency of their work. Some serious defects in the work of the Institute were discussed, and the Collegium adopted a resolution for the further development of its work and of closer connection between this work and production [33]. This latter recommendation of closer connection with practice is the perpetually reiterated topic of all scientific institutions in the Soviet Union.

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In the same year [34] the Collegium also discussed and approved a five-year plan of work for the TsNIIGAiK with working topics as follows:

Geodesy	21 topics
Astronomy	6 topics
Aerial Surveying and Photogrammetry	8 topics
Cartography	11 topics

It is obvious from the above examples, and many others of the same type could be quoted, that the Collegium of the GUGK exercises a very definite and strict control over the activity of the TsNIIGAiK. Specifications developed at the Institute for geodetic control, instrumentation, methods of surveying, etc. are considered by the Collegium and some of them are adopted for practice throughout the U.S.S.R. regardless of what agency is involved.

Such close inter-connection between practice and scientific research can produce good results only if the governing body, in this case the Collegium of the GUGK, is competent. The detailed composition of the Collegium is not known. The present head (and of the whole GUGK) is A. Baranov, not known for his scientific work. However, it is known that F.N. Krasovskiy was for a long time a member of the Collegium (1939-1948) and the participation of other prominent geodesists in the Collegium is quite likely.

Reports on the scientific work carried out at the Institute are published at the present time in the Sbornik NTPS as well as in the Trudy, TsNIIGAiK which was first issued in 1931 and the current volume of which is 80 (1953). This serial contains a tremendous amount of material, yet it is evident that not all of the Institute's work is pub-

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lished there. For instance, in all of the available issues of the Trudy, there is not a single reference to the work of the Laboratory of Radio-Waves as applied to the problems of geodesy (Laboratory D of list No. 2). It is not even mentioned in the very detailed account of the Institute's activity in 1940 [29]. Yet, from other sources [35] it is known that during the period of 1936-1939, A.I. Gruzinov and L.I. Mindlin of the Radio-Geodetic Laboratory of the TsNIIGAiK conducted very significant experiments concerning the radio-location problem using apparatus made in the U.S.S.R. We can, therefore, assume that some of the work of the Institute never finds its way into print.

Major activities of the Institute can be as described only briefly in this report for to discuss them thoroughly would mean writing the report on each of the subjects covered by the entire project. The most important features, however, are as follows:

1. General theory of the ellipsoid. The treatment and adjustment of all known triangulation and the use of the gravity survey was the life work of F. N. Krasovskiy. From 1940 onward Krasovskiy's pupil, A.A. Izotov, now one of the outstanding geodesists in the U.S.S.R., carried out most of the work in this field. Numerous papers on this subject were published by him, his final paper appearing in Vyp. 73 of the Trudy TsNIIGAiK (1950).

2. Theory of photogrammetry and design of photogrammetric equipment. There is a large group of scientists working on these problems under the leadership of F.V. Drobyshev. M. D. Konshin and G.B. Romanovskiy are also well known. Drobyshev is undoubtedly an outstanding man in design of all sorts of equipment, and a multiplex of his construction is widely used in the U.S.S.R.

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3. Theory and design of photographic lenses. In this field the leader is considered to be M. M. Rusinov, a man whose numerous cameras, such as LIAR-6 (before 1934) and Russar-1, and Russar-22 are used in photogrammetry.

4. Gravity in application to geodetic problems. The geodetic significance of gravity measurements was realized very early in the Soviet Union and gradually the so-called gravimetric geodesy became one of the main activities of the Institute. Present leaders in this field are I.A. Kazanskiy, M.S. Molodenskiy, N.N. Pariyskiy, M.E. Kheyfets and G.I. Rudakovskiy. The latter is also well known for his design of gravimetric apparatus. Trudy TsNIIGAiK Vyp. 11, (1936), 17 (1937) 29 (1939), 36 (1940), 42 (1945), 51 (1948), 66 (1949) and 75 (1950) are wholly devoted to this problem. The gravimetric group must be rather large for in the above-named publications, 13 different authors are involved and reference is made to many more participating in the design of instruments, expeditions, theoretical work, etc.

5. Time Service. The attention paid by the Soviets to the organization of a satisfactory time service is extraordinary. A large group is working on this problem at the Institute, a rather remarkable fact considering that there is also a very large and active group engaged in the same research at the Shternberg Astronomical Observatory (Moscow University), as well as at Pulkovo, Tashkent and Poltava Observatories and the Institute of Weights and Measures in Leningrad. Apparently the Soviets are convinced that the world system of longitudes in not as reliable as is commonly assumed. For purely practical purposes it was deemed necessary to establish a network of longitude stations where observers, before setting out on expeditions, could determine their personal equation. Such stations are known to exist in Moscow, Sverdlovsk and Tbilisi.

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The leader and organizer of the time service work at the TsNIIGAiK was N.P. Dolgov, but the present director of the service is A.N. Kuznetsov, very active in his field. P.S. Popov is recognized as a leader in the design of clocks and other apparatus for this work.

6. Cartography. Senior leaders in cartography before 1940 were V.V. Kavrayskiy, M.D. Solov'yev and K.A. Salishchev, none of whom appear to be connected with the TsNIIGAiK at the present time. The cartographic group is undoubtedly very large, the number of different authors on cartographic subjects in the Trudy being at least 18 in number. All aspects of cartography are considered and very detailed investigations on such involved subjects as the "load" for maps of different scales (V.I. Sukov), methods of geographic description in cartography (A.A. Borzov), precision of maps (N. M. Volkov), etc. were considered.

B. ACADEMY OF SCIENCES U.S.S.R.

The strongest Academy of Sciences, that of the U.S.S.R. has been engaged in surveying and mapping the territory of the U.S.S.R. since its foundation in 1726. In its new charter of November 23, 1935, the responsibility of the Academy for the investigation of all of the natural resources of the country is again emphasized. If we recall that the main task of the Academy is the development of science (which in the U.S.S.R. means all organized intellectual activity) it is clear that the work of the Academy has an immediate and important bearing on the problem of mapping and charting.

The Academy is divided into eight sections as follows:

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1. Physical and Mathematical Sciences
2. Chemical Sciences
3. Geological and Geographical Sciences
4. Biological Sciences
5. Technical Sciences
6. History and Philosophy
7. Economics and Law
8. Literature and Language

In 1949 there were in these sections:

56 Research Institutes
15 Laboratories
4 Observatories
7 Museums
5 Stations
51 Committees and Commissions

These establishments were scattered all over the U.S.S.R. in various branches of the Academy, with greatest concentration in Moscow (the seat of the main Academy) and Leningrad.

In regard to the committees and commissions the following should be noted. These are essentially temporary organizations set up for a specific purpose. Thus, the Yakutskaya Komissiya, for instance, (Yakutia Commission) existed for a period of five years (1925-30). After publishing its results which included very valuable geographic and geodetic studies, it was discontinued. On the other hand, the Mongol'skaya Komissiya (Mongolia Commission), organized in 1926 for the study of Mongolia, is still in existence. The number of expired commissions runs into several hundreds.

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In 1949 there were only 146 members and 255 corresponding members of the Academy. Part of the members and all of the corresponding members are on the staff of other research and instructional institutions and their connection with the actual work of the Academy is often very tenuous. The tremendous amount of research accomplished at the Academy is done by a special staff which consisted of 6,053 workers in 1949. Of these, 918 had the degree of Doctor of Science, and 2,455 were Candidates of Science. The total number of people connected with the Academy, including technical and administrative personnel, was 20,100 in 1949.

It should be noted that some of the research institutes of the Academy have a right to accept aspirants for the doctor's and candidate's degree. In 1949 the number of such aspirants was 1,734.

The president of the Academy at the present time (1953) is A.N. Nesmeyanov, an organic chemist by education.

Several organizations involving the entire academy were created for the study of the natural resources of the country. This resulted in, among other things, much cartographic activity, the occasional determination of astronomical positions, gravity measurements and even local triangulations. Such were, for instance,

Osobyy Komitet po Issledovaniyu Soyuznykh i Avtonomykh Respublik (Special Committee for the Investigation of Federated and Autonomous Republics), 1926-1928, replaced by the Komissiya Ekspeditsionnykh Issledovaniy (Commission for Expeditionary Investigations) in 1928-1930. Both organizations published numerous reports.

In 1915 another type of organization was developed within the Academy: Komissiya po Izucheniyu Yestestvennykh Proizvoditel'nykh Sil Rossii, known as KEPS, (Commission for the Study of the Natural Productive Potential of

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Russia), which had a special geographical department. In 1930 this commission was divided into several research institutes, one of which became the Institute of Geography. This commission was replaced by the Sovet po Izucheniyu Proizvoditel'nykh Sil, known as SOPS (Council for the Study of the Productive Potentialities) which exists at the present time.

Both KEPS and SOPS have been exceedingly active in the study of natural resources with special emphasis on geography and cartography. The total number of volumes printed by these organizations is over 1,000.

The above-described organizations involve not only many members of the Academy but also many outsiders. In addition to such organizations there are a number of research institutes attached to the Academy. Some of these institutes have a definite connection with geodesy and cartography:

1. Institute of Geography (Moscow, Staromonetnyy Per. No. 29)

This institute went through several transformations and changes of name:

Promyshlenno-Geograficheskiy Otdel KEPS, 1918-1931.

Geomorphologicheskiy Institut, 1931-34

Institut Fizicheskoy Geografii, 1934-37.

Institut Geografii 1937-present.

The work of the Institute is both of theoretical and applied character. Numerous expeditions of the Institute have been sent out to all parts of the Union, and have supplied detailed geographical information of such regions as Kamchatka, Altay, Kola Peninsula, etc.

The Institute is engaged in the compilation of a large reference work, "Geography in the U.S.S.R.", which is designed to embody all that is known of the physical and economic geography of the country.

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The present director of this Institute is A.A. Grigor'yev,* now about 70 years old. Grigor'yev has been rewarded for his work by many decorations and distinctions, but of late he and the entire institute have been bitterly criticized in the Soviet press.

The circumstances of this controversy are so typical of Soviet scientific life in general that it may be worth while to discuss it in detail. The attack began with an article by a certain Vasil'yev in the newspaper, "Kul'tura i Zhizn'", of March 31, 1950, which condemned the work of the Institute as well as the work of Grigor'yev himself. This resulted in a welter of articles in Russian geographic literature, mostly of derogatory contents. However, a few writers had the courage to come to Grigor'yev's defense. Finally on June 7, 1950, the Presidium of the Academy of Sciences released a statement in which the reasons for the unsatisfactory situation in the Institute were given as follows:

1. Detachment of scientific work from the practical demands of socialistic construction.

2. Errors in a number of theoretical postulates of A.A. Grigor'yev.

3. Absence of critique and self-critique in the Institute.

4. Incorrect methods of organization and planning of scientific work.

5. Absence of necessary connection with other geographical institutions of the country.

The most important accusations are (1) and (3). Any research must be directed toward the problem of the development of the country. By critique is usually meant emphasis on Soviet achievements as contrasted with foreign achievements. Grigor'yev was particularly accused because he paid homage to the German geographer, Ritter, and failed to sufficiently emphasize the

* According to the Great Soviet Encyclopedia Vol. 10, 1952 the director of this institute since 1951 is I.P. Gerasimov, a much younger man (born 1905).

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work of Russian geographers. Self-criticism generally means watchfulness lest one's theories be in conflict with dialectical materialism as interpreted by the communistic party.

This Institute, organized to direct the theoretical development of geography in the U.S.S.R. is particularly vulverable to such accusations. Any attempt to generalize scientific experience must run the gauntlet of "critique and self-critique". This is very obvious in every science, be it astronomy or zoology. The particular results of a science are considered in an entirely different light with a strongly pragmatic approach to the subject. Thus, the work of the Institute was condemned not because it was not good in a scientific sense but because it did not apply to the "practical" problems of building canals, developing reforestation, location of natural resources, etc.

Apparently Grigor'yev weathered this storm. In 1951 we find him as editor in chief of the very vitriolic book published by the Academy, "Bourgeois Geographers in the Service of American Capitalism".

The Institute of Geography is currently publishing its results in two serials; "Trudy" (1931-1951, about 50 volumes printed) and "Problemy Fizicheskoy Geografii" (1934-1951, 13 volumes), as well as in general Academy publications. Of special interest is the development of cartometry at the Institute. A book by N.M. Volkov on this subject was published by the Institute in 1950.

Special cartographic work is being done in several other institutes of the Academy such as the

a. Institute of Soils (Pochvennyy Institut), where a soil map on the scale of 1:2,500,000 has been compiled covering all of the U.S.S.R., and a map on a 1:1,000,000 scale is in the process of preparation.

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b. Institute of Geology (Institut Geologicheskikh Nauk), Institute of Permafrost (Institut Merzlotovedeniya) and Institute of Forestry (Institut Lesa) are also engaged in the mapping of the territory of the U.S.S.R., each for its own specific purposes.

2. Laboratory of Aerial Methods (Laboratoriya Aerometodov), Moscow, Staromonetnyy Pereulok, No. 35.

This Laboratory was established in 1944 as a further development of the Commission for the Application of Aerial Surveys.

The basic tasks of the Laboratory are the development of methods for the utilization of results of aerial surveying, aero-visual observations and aerial magnitometry.

Major results of the Laboratory are published in a serial, "Trudy Laboratorii Aerometodov", Vols. 1-2 (1949-1950), which consist of theoretical papers on photogrammetry as well as of application of aerial surveys. Especially interesting is the emphasis of the Laboratory on spectral photography. In 1947, a special book was published on "Spectral Reflectivity of Natural Formations" by E. L. Krinov which gives a large number of data on this subject.

During the war the Laboratory was engaged in the development of a system of photo-interpretation for aerial photographs of important objects photographed in the enemy's territory.

The director of the Laboratory was P.I. Stepanov (1945).

3. Institute of Geophysics (Geofizicheskiy Institut), Moscow, Pyzhevskiy Pereulok, No. 3-5.

This was formerly the Institute of Seismology, founded in 1928. At that time it had a central seismological station in Moscow and stations at 21 other points of the Union and its work was largely of a seismological

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character, with some attention given to the problems of gravimetry. In 1947 this Institute was combined with another Institute of the Academy, the Institute of Theoretical Geophysics, to form an Institute of Geophysics. Under the new director, G.A. Gamburtsev, the Institute of Geophysics (Institut Geofiziki) has greatly enlarged the scope of its activity. It publishes the Trudy Geofizicheskogo Instituta (Vol. 1-13, 1948-50) which are a continuation of the Trudy Seysmologicheskogo Instituta, as well as numerous papers in the publications of the Academy.

There is also a section of gravimetry and geodesy in the Institute under the leadership of Yu. D. Bulanzhe, one of the well known Soviet gravimetrists. The work of this section consists in determination of gravity points as well as in the interpretation of that data. In other sections of the Institute such problems as the movements of the earth's curst and their effect on geodetic measures are considered. Considerable attention is also paid to the structure of the atmosphere of the earth and the propagation of radio-waves.

4. Institute of Physics (Fizicheskiy Institut), Moscow 3-ya Miusskaya, No. 3. This Institute is engaged in research in various phases of physics and, as such, is of no particular interest in the present connection. However, one section of it under L.I. Mandel'shtam and N.D. Papaleksi, was very active in research on the problems of the propagation of radio waves and their application to the problems of geodesy and of radio location.

In 1938 at the Academy an All Union Scientific Council of Radio-Physics and Radio-Technology was established (Vsesoyuznyy Nauchnyy Sovet po Radiofizike i Radiotekhniki) under Papaleksi, the task of which was to coordinate all such research. Both Mandel'shtam and Papaleksi are dead now and the president of the Council in 1951 was B.A. Vvedenskiy, one of the outstanding

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radio-physicists in the country. He is also chairman of a section for the scientific development of the problems of radiotechnics (Sektsiya po Nauchnoy Razrabotke Problem Radiotekhniki) which is apparently a newly established organization, not existing in 1945.

5. Institute of Theoretical Astronomy (Institut Theoreticheskoy Astronomii), Leningrad, Universitetskaya Naberezhnaya, No. 5.

This Institute (the present director is M.F. Subbotin) was organized in 1943 to replace the former Astronomical Institute which had existed since 1920. The Astronomical Institute was very active in the gravimetric survey of the U.S.S.R. At the present time the Institute of Theoretical Astronomy is publishing in its Bulletins and Trudy many papers on the theory of gravimetry, the shape of the earth, etc., as well as almanacs for the Navy and Air Forces.

6. Pulkovo Observatory was formerly the training center for military geodesists and has in the past contributed very substantially to the development of geodesy in Russia. At the present time its only connection with geodesy is the fact that it is the initial point for all triangulations in the U.S.S.R. (Pulkovo Datum) and one of the five fundamental points for gravity surveys. Indirectly, however, it still contributes to the problems of geodesy through its study of the variation of latitude and time, and in furnishing star positions for geodetic needs. Its present director, A.A. Mikhaylov, is a noted authority in gravimetry.

7. The Geographic Society (Vsesoyuznoye Geograficheskoye Obshchestvo), Leningrad, Demidov Pereulok, No. 8a.

This is a tremendous organization which had a membership of 4,244 in 1950 and 36 sections scattered over the U.S.S.R. In the past the Society was famous for the organization of expeditions to Central Asia such as those

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of Przheval'skiy, Kozlov, Potanin, Pevtsov, and many others. At the present time its role appears to be restricted to theoretical discussions of the problems of geography. Nevertheless, its publications, "Izvestiya" and "Zapiski", are among the most valuable serials published on Russian geography.

The Moscow section of the Society is very active. It is publishing its own serial, "Voprosy Geografii", consisting mostly of contributions submitted by the geographers at Moscow University.

8. The Astronomic-Geodetic Society (Vsesoyuznoye Astronomo-Geodezicheskoye Obshchestvo) is mentioned here only because of its misleading name. This is an amateur society which directs amateur astronomical activities. Its connection with geodesy is restricted to discussion of geodetic problems.

9. Expeditions of the Academy. The Academy has organized many expeditions to little known territories. These expeditions are usually of the "complex" type; that is, a region is studied from every point of view. Even if the expedition has a primary aim of anthropology or botany, some cartographic material is usually gathered. The number of such expeditions is very large (certainly over 1,000) and some of them have lasted for years and employed hundreds of people.

Of the most important expeditions from the cartographic point of view, the following should be noted:

a. Tadzhik-Pamir Expeditions of 1928-35, a whole series of expeditions resulting in more than 100 volumes of printed material.

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b. Yakutia Expedition, 1925-30, published in "Trudy" and "Materialy" of the Yakutskaya Komissiya, the first reliable data on the geography of that region.

c. Kamchatka Expedition (1936-37).

d. Karakalpak Expedition (1931-32).

e. Far East Expedition (1933).

The results of more recent expeditions are generally published in the Trudy SOPS, arranged regionally in 21 series, such as Seriya Ural'skaya, Seriya Kazakhskaya, etc.

C. OTHER ACADEMIES

The Academy of Sciences, U.S.S.R., has a number of regional sections known as "filialy", such as Kazanskiy Filial at Kazan'. In 1949 there were 16 such sections to which 34 research institutes were attached. The work of such "filials" is largely, but not wholly, of local significance. Some "filials" in other republics of the Union attain a certain status of activity and become independent Academies of Sciences.

The largest of such Academies is that of the Ukrainian Republic which had 82 members, 88 corresponding members, and 1,300 people on its research staff in 1949.

The activity of the Ukrainian Academy of Sciences in geography and mapping is not very significant. However, it organized several geographic expeditions, one of them to Tyan'-Shan' (1935). It has a unique Gravimetric Observatory at Poltava which, under the direction of A. Ya. Orlov, has been very active in gravimetric surveys, studies in variation of latitude, movements of the earth's crust, etc.

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Other republic Academies are as follows:

1. Azerbaydzhanskaya, founded in 1945 in Baku, has an Institute of Geography which published a detailed study of the geography of Azerbaydzhan in 1945. Scientific staff of the Academy in 1949: 444 people.

2. Armyanskaya, founded in 1943 in Yerevan. Scientific staff in 1949: 569 people.

3. Belorusskaya, founded in 1929 in Minsk. Scientific staff not known but probably does not exceed 500 people.

4. Gruzinskaya, founded in 1941, in Tbilisi. The scientific staff in 1949 consisted of 908 people. There is an Institute of Geography and a very active Geophysical Observatory at Tbilisi, now a part of the Institute of Physics and Geophysics.

5. Kazakhskaya, founded in 1946, in Alma-Ata. Scientific staff: about 1,000 people. Considerable research is done on the problem of scattering and visibility in the atmosphere.

6. Latviyskaya, reorganized in 1940, in Riga. There is an Institute of Geology and Geography here.

7. Litovskaya, founded in 1941, in Vil'nyus.

8. Uzbekskaya, founded in 1943, in Tashkent. The academy has the Tashkent Astronomical Observatory, the Latitude Station at Kitab, and the Seismological Station in Samarkand. There is also a Cartographic Bureau. Nothing is known about the activity of the latter.

9. Estonskaya, founded in 1946 in Tartu.

10. Tadzhikskaya, founded in 1951, in Stalinabad.

11. Turkmenskaya, founded in 1951, in Ashkhabad'.

All these Academies publish a tremendous amount of material in their special serials. Some of this material may be of considerable interest

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from the point of view of geodesy and cartography.

B. GLAVSEVMORPUT'

Glavnoye Upravleniye Severnogo Morskogo Puti (abbreviated Glavsevmorput', Main Administration of the North Sea Route) is a very large organization created in 1932 for the purpose of securing the passage from the White Sea ports to Vladivostok along the north coast of Siberia. This task involved a thorough study of the Arctic from every point of view for which purpose a research institute was organized. It is known as the Arkticheskiy Nauchno-Issledovatel'skiy Institut (Arctic Scientific Research Institute). There are also several other organizations in the system of the Glavsevmorput' which are engaged in mapping activities, as will be explained below.

1. Arctic Institute

The Arctic Institute began in 1920 as Severnaya Nauchno-Promyslovaya Ekspeditsiya (Northern Scientific and Industrial Expedition). In 1925 it was transformed into the Institut po Izucheniyu Severa (Institute for the Study of the North). In 1930 it received its present name and O. Yu. Shmidt was appointed its director. In 1932 the Glavsevmorput' was organized and the Arctic Institute became its research organ. O. Yu. Shmidt was appointed head of the entire Glavsevmorput' and was replaced at the Arctic Institute by R.F. Samoylovich, a noted authority on the Arctic. The present director of the Institute is V. Kh. Buynitskiy.

The activity of the Institute up to 1940 was very impressive. All aspects of the Arctic, north of the 60th parallel, were studied and a tremendous number of volumes published. Many expeditions were organized and

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hundreds of astronomical positions and gravimetric measures were made, as well as thorough studies of terrestrial magnetism, ionosphere, climate, hydrography, etc.

Up to 1945 the Institute compiled 185 maps of the Arctic of which only 72 were published. The general map of the Arctic on the scale of 1:6,000,000 was considered in 1945, as the most reliable of the existing maps. Detailed maps of Yamal-Gydan' and Chukotskiy peninsulas, and of the Lena-Khatanga, Lena-Indigirka, Nizhnyya Tunguska regions, etc. were compiled.

In 1940 the activity of the Institute was much circumscribed [36] and confined to three main avenues of investigation: ice and weather service, marine hydrology and geophysics. All cartographic activity was to be assumed by the hydrographic section of the Glavsevmorput'.

The main publication of the Arctic Institute is "Trudy" of which over 250 volumes are in existence. Since 1940 great secrecy surrounds Soviet operations in the Arctic and only volumes of the "Trudy" devoted to biology are permitted outside the Soviet Union. Up to 1940 many volumes contained astronomical determinations, topographic maps, climatological studies, etc. Especially important was the gravimetric work organized mostly by I.D. Zhongolovich of all the Soviet Arctic including the North Pole region. In his report [47] of 1940 he gives the location of determinations but not the values of gravity itself. It appears that between 1936 and 1940, 328 such determinations were made, very few of which were published. In the new Great Soviet Encyclopedia, 1950, the Arctic Institute is not mentioned at all.

2. Hydrographic Administration

The Hydrographic Administration of the Glavsevmorput' (Gidrograficheskoye

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Upravleniye Glavsevmorputi), not to be confused with the Hydrographic Directorate of the Marine Navy (Gidrograficheskoye Upravleniye Morskogo Flota) has been very active along the coasts and inland waterways of the Arctic. No comprehensive report covering its activity is available. However, from its serial, "Severnyy Morskoy Put'", we gather that practically every large and small river in the Arctic has been surveyed and atlases on a scale of 1:50,000 and 1:25,000 have been prepared. Volume 1 (1937) of another serial published by the Hydrographic Directorate is available. It contains about 700 astronomical determination and triangulation positions made along the coast of the Arctic.

3. Mining-Geological Administration

The Mining-Geological Administration of the Glavsevmorput' (Gorno-Geologicheskoye Upravleniye Glavsevmorputi) is chiefly engaged in studying mineral deposits in the Arctic. It publishes its own serial, "Trudy" (Vol. 30, 1947) from which it is evident that considerable cartographic activity is also carried on by this Administration.

4. Arctic Intelligence

The only reference to the "Arktikrazvedka" (Arctic Intelligence) so far found is in the list of participants of the 2nd Conference on the Problems of Latitude Variation, held in Moscow in 1950. A person, otherwise unknown, V. Kh. Galeyev, represented this organization, the headquarters of which are in Moscow. Apparently it is interested, among other things, in purely geodetical problems.

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E. MILITARY ORGANIZATIONS

Some research in geodesy and cartography for specific purposes is undoubtedly conducted in military institutes, but very little is known about the activity of these organizations.

The Scientific Research Institute of Military Topographic Service (NIIVTS in Moscow) has been publishing monographs and instruction books on the subjects of geodesy and cartography, paralleling the work of the TsNIIGAiK. It is in all probability a much smaller institution than the TsNIIGAiK. None of the publications of NIIVTS have been found in this country, and they are known only from reference to them in open sources.

The connection of the military with research projects in the U.S.S.R. is rather carefully concealed and it is not easy to obtain even the roughest outlines of work along these lines. In the award of the Stalin prizes for 1950, the authors of the Volume 1 of the Marine Atlas (Morskoy Atlas) were enumerated. Among these we find Professor I.S. Isakov. In the Great Soviet Encyclopedia Vol. 18, 1953 we find that this Professor Isakov is an admiral of the navy and head of the Military Naval Academy.

This academy even though being primarily a training center, is rather strong in cartographic research. One of the best known Soviet cartographers V.V. Kavrayskiy is an admiral and is chairman of Geodesy and Astronomy in the academy.

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APPENDIX A

EXAMINED SOURCES

1. Medynskiy, E.N., Narodnoye Obrazovaniye v SSSR, 1947, p. 20.

2. Sredniye Spetsial'nyye Uchebnyye Zavedeniya SSSR, 1948.

3. Spravochnik dlya Postupayushchikh v Vysshiye Uchebnyye Zavedeniya, 1950. After the compilation of this report the 1952 edition of this handbook became available. It is, however, much less detailed and less revealing than the 1950 edition.

4. Titul'nyy Spisok Vysshikh Uchebnykh Zavedeniy, 1946.

5. Sementovskiy, V.N., Voprosy Geografii, Sbornik 25, 1951, pp. 56-82.

6. Aleksakov, N.I., Vestnik Vysshey Shkoly, 1951, No. 5, pp. 34-36.

7. Zemskova, Yu. A., Vestnik Vysshey Shkoly, 1951, No. 6, pp. 21-41.

8. Aspirantura Vysshikh Uchebnykh Zavedeniy, 1949.

9. Vysshaya Shkola, Osnovnyye Postanovleniya, 1945, p. 289.

10. Markov, K.K., Tridtsat' Let so Vremeni Organizatsii Vysshego Geograficheskogo Uchebnogo Zavedeniya v Nashey Strane, Voprosy Geografii, Vyp. 3, 1947, pp. 200-209.

11. Baranskiy, N.N., Geograficheskiy Printsip v Organizatsii Geograficheskogo Izucheniya Territorii, Voprosy Geografii Vyp. 23, 1950, pp. 19-56.

12. Podobedov, N.S., O Postanovke Geograficheskikh Rabot, etc., Sbornik NTPS, Vyp. 16, 1948, pp. 57-69.

13. Sbornik NTPS, Vyp. 13, 1946.

14. Podobedov, N.S., Sbornik NTPS, Vyp. 8, 1945, p. 92.

15. Salishchev, K.A., Podgotovke Kadrov Geografov, Vestnik Vysshey Shkoly, 1951, No. 7, pp. 5-14.

16. Salishchev, K.A., O Postanovke Vysshego Kartograficheskogo Obrazovaniye v SSSR, Voprosy Geografii, Vyp. 25, 1951, pp. 83-97.

17. Spravochnik dlya Postupayushchikh v Moskovskiy Universitet v 1949 g.

18. Voprosy Geografii, Vyp. 25, 1951, p. 11.

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19. Vestnik Leningradskogo Universiteta, No. 5, 1951.

20. Geodezist No. 8, 1940.

21. Tekhnicheskaya Ucheba, Vol. 8, 1939.

22. Sel'skokhozyaystvennaya Akademiya imeni K.A. Timiryazeva, 1946.

23. Kuda Poyti Uchit'sya, 1950 and 1951.

24. Sbornik NTPS, Vyp. 24, 1949, pp. 83-84.

25. XX-Let Sovetskoy Geodezii i Kartografii, Vol. 1, 1940.

26. Sbornik NTPS, Vyp. 6, 1944, pp. 49-56.

27. Sredniye Spetsial'nyye Uchebnyye Zavedeniya, 1948, pp. 107-108.

28. Kuda Poyti Uchit'sya, reference book for prospective students in Moscow region, 1947.

29. A series of 15 articles in the "Geodezist" No. 5, 1940, reviewing the work of the TsNIIGAiK.

30. Armand, A.A., Nauchno-Issledovatel'skiye Instituty Tyazheloy Promyshlennosti, 1935, pp. 747-762.

31. Danilov, V.V., Sbornik NTPS, Vyp. 22, 1948, pp. 13-25.

32. Sukhov, A.I., XX-Let Sov. Geodezii i Kartografii, 1939, pt. 1, pp. 254-270.

33. Sbornik NTPS, Vyp. 21, 1948, p. 30, Chronicle.

34. Sbornik NTPS, Vyp. 16, 1948, Chronicle.

35. Mandel'shtam, L.I. and Papaleksi, editors, Noveyshiye Issledovaniya Rasprostraneniyn Radiovoln vdol' Zemnoy Poverkhnosti, M.L., 1945.

36. Problemy Arktiki 1940, No. 7-8, p. 106.

37. Zhongolovich, I.D., Problemy Arktiki, 1940, No. 2.

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APPENDIX B

Rules of Admission to Institutions of Higher Learning of the U.S.S.R. for 1950.

(Confirmed by the Ministry of Higher Education of the U.S.S.R. 28 January, 1950).

I. Accepted in VUZY - Citizens of U.S.S.R. of both sexes from 17 to 35.

- in Correspondence and Evening VUZY (divisions) - without definite age limit, provided they have completed an intermediate education and successfully passed the examinations set up for those entering these educational institutions.

Note: - (a) Persons who have graduated from tekhnikums or other intermediate specialized educational institutions comparable to them, will be accepted in VUZY provided they have completed the three years' production experience established by law after completion of the intermediate educational institution. Such experience is not required of those enrolling in correspondence and evening VUZY and divisions, nor from those included in the upper 5% of those graduated from each tekhnikum, as well as from those people who, at the close of a tekhnikum, are participating in the three or more years program of active military service.

(b) In accordance with decree No. 426 of the Sovet of Ministers of the Union of SSR of Feb. 1, 1949, it has been decided to temporarily accept for a period of five years, for the first course of teachers' institutes without preliminary experience by the enrollees, those who have completed pedagogical training schools under the direction of the ministries of Education of the Union Republics.

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II. Those people who, at the close of intermediate schools, have been awarded gold or silver medals "For outstanding successes and exemplary conduct," will be accepted in institutions of higher learning without entrance examinations, provided that, first of all, there shall be admitted those awarded the golden medal and next those awarded the silver medal.

Also without entrance examinations will be accepted those persons who have completed tekhnikums with a rank of "excellent", those included within the upper 5% of those graduated from a tekhnikum or a three-year intermediate medical school and who enroll in institutions of higher learning according to their specialty within two years, including the year of completion.

Note: - Those persons awarded gold and silver medals, and outstanding graduates who have completed tekhnikums (intermediate specialized educational institutions), who enroll for architectural and construction specialties, shall take examinations in drawing and drafting; those enrolling in art, music and physical culture higher educational institutions shall take examinations according to their specialty.

III. Those enrolling in higher educational institutions, with the exception of those mentioned in paragraph 2, shall take entrance examinations depending upon the specialty of the higher educational institution:

1. in VUZY and faculties of machine-construction, metal-work, metallurgy, mechanics, electrical mechanics, electrical technology, energetics, communications, mining, geology, oil, aviation, geodesy, hydrometeorology, hydrography, auto-transport, railroad, water transport, forestry, chemical technology, cinema-engineering - in the following subjects:

a. mathematics, b. physics, c. chemistry, d. Russian language and literature, e. one foreign language (English, French or German);

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2. in VUZY and faculties of architecture and building - in the following subjects:

a. mathematics, b. physics, c. drawing and drafting, d. Russian language and literature, e. one foreign language (English, French or German);

3. in VUZY and faculties of philology, linguistics, philosophy - in the following subjects:

a. Russian language and literature, b. history of peoples of the U.S.S.R., c. geography, d. one foreign language (English, French or German);

4. in institutes and faculties of physics - mathematics, chemistry, land exploitation, agricultural construction, peat textiles, light industry, trade, automobile-roads, polygraphy, mechanization and electrification of agriculture, forest economy, forest improvement and hydromelioration - in the following subjects:

a. mathematics, b. physics, c. chemistry, d. Russian language and literature;

5. in VUZY and faculties of biology, soil science, agronomy, zoo-technics, veterinary medicine, medicine, stomatology, pharmacology, physical cutlure, - in the following subjects:

a. physics, b. chemistry, c. Russian language and literature;

6. in VUZY and faculties of history, jurisprudence, geography, library science, and also in pedagogical faculties of pedagogical institutes - in the following subjects:

a. history of peoples of the U.S.S.R., b. geography, c. Russian language and literature;

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7. in institutes and faculties of economics and engineering-economics - in the following subjects:

a. mathematics, b. geography, c. history of peoples of the U.S.S.R., d. Russian language and literature;

8. in higher musical, theatrical and art educational institutions and institutes of cinematography - in the following subjects:

a. history of peoples of the U.S.S.R., b. specialties, c. Russian language and literature;

9. those enrolling in teachers' institutes shall take entrance examinations in the following subjects:

A. in the division of language and literature - a. in Russian language and literature, b. history of peoples of the U.S.S.R., c. geography;

B. in the history division - a. in Russian language and literature, b. history of peoples of the U.S.S.R., c. geography;

C. in the natural science-geographic division - a. in Russian language and literature, b. geography, c. chemistry;

D. in the physics-mathematics division - a. in Russian language and literature, b. mathematics, c. physics;

Note: 1. Those enrolling in VUZY, where the instruction is carried on not in the Russian language, shall also take an examination in the language in which the instruction in the given VUZ is carried on.

2. Those enrolling in universities shall take an entrance examination (in addition to the aforementioned, depending upon the faculty) in one foreign language (English, French, German) independently of the specialty.

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IV. Entrance examinations shall be given in accordance with the programs approved by the Ministry of Higher Education of the U.S.S.R.

In the case of the Russian language and the language in which the instruction of the given higher educational institution is carried on, as well as in the case of mathematics both written and oral examinations will be given, in the case of all other subjects only oral.

In the case of the Russian language and the language in which the instruction in the given higher educational institution is carried on, separate grades both for the written as well as for the oral examinations will be posted; in the case of mathematics one overall grade shall be posted on the basis of the written and oral examinations.

Note: Separate grades for written and oral examinations in mathematics will be posted at physics-mathematics faculties of universities and pedagogical institutes.

V. Persons who have received an unsatisfactory grade on the written examination in the Russian language or the language, in which the instruction in the given VUZ is carried on, shall not be admitted to further examinations.

VI. From the number of those passing the entrance examinations, i.e., receiving a grade of not lower than "second-rate," those having the highest grades shall be enrolled in institutions of higher learning. Persons who have passed the examinations but are not accepted because of lack of vacant places in that faculty (fakul'tet) in which they have passed the examinations may be accepted in another faculty, where there are open places after enrollment of the candidates who have passed examinations in that faculty, on condition that they pass additional examinations set up for those enrolling in that faculty.

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VII. Applications for enrollment in higher educational institutions will be received from June 20 through July 31.

In applications for enrollment the "faculty" and specialty chosen by the applicant must be indicated. Applications shall be turned in to the name of the director of the higher educational institution with the addition of:

a. an autobiography

b. an affidavit of completed work (diploma) from an intermediate educational institution (in the original),

c. a passport (presented personally),

d. three photographs (snapshots without hats, size 3 x 4 centimeters),

e. statements of military status (for those subject to military duty),

f. statements from the place of work, together with indication of the duties and specialties of occupation (for correspondence and evening VUZY and divisions).

VIII. Under the director's personal chairmanship there shall be organized an admissions commission composed of the vice-director on educational and scientific work, the deans of the faculties and two professors.

The director and members of the admissions committee are obliged personally to become acquainted with each applicant and to verify personally all the documents of the applicants.

The director is obliged, within five days from the day of receipt of the application, to notify the applicant of the results of the preliminary consideration of his application.

IX. Entrance examinations shall take place from the first through the twentieth of August.

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X. Enrollment in the student body shall take place from the 21st through the 25th of August, and the enrollment of students indicated in paragraph 2 from the 21st through the 31st of July, according to the receipt of their applications.

XI. Entrance examinations shall be given by specialized examining commissions, appointed by the director.

XII. For each applicant an examination paper together with a photograph card shall be handed in.

XIII. The results of the entrance examinations shall be indicated separately for each subject with the following grades (marks): "otlichno" (excellent), "khorosho" (good), "posredstvenno" (average), "neudovletvoritel'no" (unsatisfactory).

XIV. The director of the higher educational institution shall organize the medical examination of all applicants. The list of illnesses which prevent admission to the corresponding higher educational institution shall be confirmed by the Ministry of Health of the U.S.S.R. and the Ministry of Higher Education of the U.S.S.R.

XV. The results of the examinations and of the medical examination shall be submitted to the admissions commission, which makes the decision about admission into the higher educational institution. Enrollment in the higher educational institution takes place at the order of the director.

XVI. Persons, enrolled in the higher educational institutions who do not enter in their work before September 10th without good reason, shall be excluded from the student roster.

XVII. The directors of higher educational institutions may determine, in the case where vacancies arise, to accept on the roster of students those

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people who have passed the examinations in another higher educational institution, but who were not admitted to it because there is no vacancy or in view of the lack of correspondence between requirements of the given specialty and a health condition, and also he (the director) shall admit to the entrance examinations persons who did not pass the examinations in another VUZY in subjects not provided for by the rules of admission in the given VUZ. The acceptance shall take place after passing of the examinations set up for the given VUZ, taking into account the examinations passed in the other VUZ.

The last day for enrolling these people indicated above shall be September 10th.

The same period shall be established for enrolling of the student mentioned in paragraph 2, and not admitted into another higher educational institution because of no vacancy.

XVIII. Complaints about refusal to enroll may be submitted from the first of the school year to the administration of the educational institutions of the corresponding Ministry (office) together with documents (autobiography; copy of attestation, excerpts from the protocol (minutes) of the examining and admissions commissions).

The administration of educational institutions shall be obliged to give an answer to the complaint not later than three days from the moment of receipt of the complaint.

XIX. As for persons not admitted to higher educational institutions, their documents shall be returned to them not later than three days after the corresponding notice or the decision of the admissions commission concerning refusal is given.

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APPENDIX C.

A. List of Russian Textbooks of Higher Geodesy.

1. Rabinovich, B.N.: Osnovy postroyeniya opornykh geodezicheskiky sety (Principles of the Construction of Fundamental Geodetic Networks). Dopushcheno Min. Vyssh. Obrazovaniya SSSR v kachestve uchebnogo posobiya dlya kartograficheskikh fakul'tetov geodezicheskikh institutov, Moskva, 1948, 323 pp.

2. Chebotarev, A.S.: Geodeziya. Chast' pervaya. ("Geodesy" - Part I, "Geodesy" - Part II 1949) Dopushcheno Ministerstvom vysshego obrazovaniya SSSR v kachestve uchebnika dlya institutov geodezii i kartografii, Moskva, 1948, 692 pp. and 636 pp.

3. Virovets, A.M. i Kutuzov, M.N.: Geodeziya. ("Geodesy") Izdatel'stvo geodezicheskoy i kartograficheskoy literatury, Moskva, 1948, 467 pp.

4. Rabinovich, B.N.: Praktikum po vysshey geodezii. ("Manual of Higher Geodesy") Dopushcheno Ministerstvom vysshego obrazovaniya SSSR v kachestve uchebnogo posobiya dlya geodezicheskikh vuzov i fakul'tetov, Moskva, 1951, 304 pp.

5. Krasovskiy, F.N.: "Rukovodstvo po Vysshey Geodezii" ("Textbook of Higher Geodesy") Chast' I. Nauchno Tekhnicheskoy Sektsiyey Gosudarstvennogo Uchenogo Soveta Dopushcheno v kachestve rukovodstva dlya Vysshikh Uchebnykh Zavedeniy, Izdaniye Moskva, 1926, 463 pp.

B. Reference Books on Geodesy.

6. Bonch-Bruyevich, M.D. (Editor): Kazanskiy, I.A.: Geodeziya, Tom I. (Geodesy, Vol. I). Izdatel'stvo Ministerstva Kommunal'nogo Khozyaystva RSFSR. Leningrad, Moskva, 1949, 422 pp.

7. Bonch-Bruyevich, M.D. (Editor): Stepanov, N.N.: "Geodeziya," Tom IX. ("Geodesy - Supplements," Vol. IX). Izdatel'stvo Ministerstva Kommunal'nogo Khozyaystva RSFSR. Leningrad, Moskva, 1949, 540 pp.

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8. Bonch-Bruyevich, M.D. (Editor): Stepanov, N.N.: "Geodeziya," Tom III. (Geodesy - Surveying and Leveling, Vol. III.). Izdatel'stvo Narkomkhoza RSFSR, Moskva, Leningrad, 1941, 364 pp.

9. Baranov, A.N.: (Editor) "XX Let Sovetskoy Geodezii i Kartografii." 1919-1939. ("20 Years of Soviet Geodesy and Cartography," 1919-1939). Sbornik Statey. 1 and 2. Glavnoye Upravleniye Geodezii i Kartografii pri SNK SSSR. Moskva, 420 pp.

C. List of "Special Type" Geodetic Textbooks

10. Bobylev, G.Z.: "Geodeziya" ("Geodesy") Gosud. Arkhitekturnoye Izdatel'stvo, Moskva, 1950, 245 pp.

11. Orlov, P.M.: "Zemlemeriye (Geodeziya) Uchebniki i Uchebnyye Posobiya dlya Sel'skokhozyaystvennykh Tekhikumov." ("Land Surveying (Geodesy) Textbooks and Training Manuals for Agricultural Technikums.") Gosudarstvennoye Izdatel'stvo Sel'skozyaystvennoy Literatury. Moskva, 1949, 327 pp.

12. Shchavelev, A.F.: "Geodeziya." ("Geodesy") Dopushcheno GUUZom Ministerstva Rechnogo Flota SSSR v Kachestve Uchebnogo Posobiya dlya Rechnykh Uchilishch i Tekhnikumov. Leningrad, Moskva 1950, 360 pp.

13. Popov, V.V.: Prof. "Uravnoveshivaniye Seti Poligonov." ("Adjustments of Polygonal Networks") Posobiye dlya inzhenerov i tekhnikov, vypolnyayushchikh geodezicheskiye raboty. Izdatel'stvo geodezicheskoy i kartograficheskoy literatury GUGK pri SNK SSSR, Moskva 1941, 148 pp.

14. Stepanov, N.N.: Inzhenernaya Geodeziya ("Engineering Geodesy") Vyssheye inzhenerno-tekhnicheskoye uchilishche VMF Izdatel'stvo Narkomkhoza RSFSR, Moskva, Leningrad, 1943, 328 pp.

15. Vydrin, F.I.: Geodeziya i marksheyderskoye delo. ("Geodesy and the Mine Surveying Service") Ugletekhizdat. Moskva, 1948. 263 pp.

16. Platon, V.M.: Spravochnoye posobiye po geodezii dlya tekhnikov-stroiteley. ("Reference Manual in Geodesy for Engineering Construction.") Izdatel'stvo Ministerstva Kommunal'nogo Khozyaystva RSFSR, Moskva, Leningrad, 1949, 211 pp.

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17. Gusev, M.I.: Kurs marksheyderskogo dela.
("A Course in Mine Surveying")
Chast' I. Dopushcheno Ministerstvom vysshego obrazovaniya SSSR v kachestve uchebnika dlya VTUZov.
Ugletekhizdat Ministerstva Vostokuglya. Moskva, Leningrad, 1948, 267 pp.

18. Bakhurin, I.M.,:
Pyatlin, M.P.,
Krotov, G.A.
Kurs marksheyderskogo dela.
("A Course in Mine Surveying")
Chast' II. Dopushcheno Ministerstvom vysshego obrazovaniya SSSR v kachestve uchebnogo posobiya dlya gornykh vuzov.
Ugletekhizdat. Moskva, Leningrad, 1949, 259 pp.

19. Shilov, P.I.: Geodeziya (dlya avtodorozhnykh vuzov).
("Geodesy" (for auto road construction)).
Izdatel'stvo geodezicheskoy i kartograficheskoy literatury. Moskva, 1950, 404 pp.

20. Min. Geology: Aerogeologicheskiye Raboty. Vypusk VIII.
(Aero Geological Works)
Ministerstvo Geologii.
Gosudarstvennoye Izdatel'stvo Geologicheskoy Literatury. Moskva, 1950, 208 pp.

D. List of Textbooks of "Lower" Geodesy.

21. Fedorov, N.V.: (Prof.) "Geodeziya." ("Geodesy")
Dorizdat. Moskva, 1949, 279 pp.

22. Belikov, S.: Kurs topografii ili nizshey geodezii.
("A Course in Topography or Lower Geodesy.")
Moskva, 1884.

23. Artamonov, N.D.: Kurs nizshey geodezii.
("A Course in Lower Geodesy")
Sanktpeterburg, 1897. Akademii Nauk.

24. Ikonnikov, A.: Elementarnaya geodeziya.
("Elementary Geodesy")
Amerikanskoye izdatel'stvo. Berlin, 1924.

25. Orlov, P.M.: Kurs Geodezii
("A Course in Geodesy")
Nauchno-tekhnicheskiy Otdel V.S.N.Kh.
Moskva, 1924, 191 pp.

26. Motornyy, A.D.: Nyzhcha geodeziya
("Lower Geodesy")
Chastyna 2 - Menzul'ne zdiymannya
Tekhinchno-teoretychne vydavnytstvo
Kharkiv, Kyiv, 1933, 103 pp.

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E. Field Instruction Manuals

27. GUGK: Instruktsiya po Sostavleniyu Kroki Geodezicheskikh Punktov.
("Instructions for the compilation of sketches of geodetic points").
Glavnoye Upravleniye Geodezii i Kartografii pri Sovete Ministrov SSSR, Moskva, 1949, 16 pp.

28. GUGK: "Instruktsiya po Triangulyatsii, II, III i IV Klassov"
("Instructions for Triangulation of II, III and IV class.")
Obyazatel'na dlya Vsekh Vedomstv i Uchrezhdeniy SSSR. Izdatel'stvo Geodezicheskoy i Kartograficheskoy Literatury GUGK pri SNK SSSR. Moskva, 1943, 128 pp.

F. Geodetic and Topographic Norms

29. GUGK: Yedinyye Normy Vyrabotki na Topograficheskiye i Geodezicheskiye Raboty.
("The Only Norms for the Production of Topographic and Geodetic Works")
Glavnoye Upravleniye Geodezii i Kartografii pri Sovete Ministrov SSSR.
Izdatel'stvo Geodezicheskoy i Kartograficheskoy Literatury. Moskva, 1949, 255 pp.

G. "Iron Curtain" Textbooks of Geodesy

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